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*Quarterly Journal*
AMERICAN CONGRESS ON SURVEYING AND MAPPING

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# Our New President

Gerald FitzGerald, Chief Topographic Engineer of the U. S. Geological Survey, was elected President of the American Congress on Surveying and Mapping for the year 1951. He was born in Burns, Oreg., on January 22, 1898, and was educated in public and private schools in Washington and Oregon. He joined the Geological Survey in 1917 and, with brief intermissions to resume studies in engineering, served continuously until 1942 on a wide variety of surveying and mapping assignments in the United States, the West Indies, and Alaska. He became a specialist on reconnaissance mapping and was placed in charge of topographic surveys in Alaska under the Alaskan Branch in 1938. In this capacity he organized and assisted in the original development of "trimetrogon mapping," a cooperative program between the Geological Survey and the Army Air Force, to provide world-wide map coverage for military operations. In recognition of this work, he received the 1944 Photogrammetric Award of the American Society of Photogrammetry for "outstanding achievement in photogrammetry."

In 1942, Mr. FitzGerald was commissioned in the Air Corps and was assigned to the Aeronautical Chart Service. He commanded this organization with the rank of Colonel from 1943 until relieved from active duty in 1946 to return to the Geological Survey as Staff Topographic Engineer. He was appointed Chief Topographic Engineer of the Survey on May 22, 1947.

GERALD FITZGERALD

Mr. FitzGerald is past President of the American Society of Photogrammetry, a Director of the American Congress on Surveying and Mapping, and a member of the American Geophysical Union, the Washington Society of Engineers, the Cosmos Club, and the Explorers Club. He received the Legion of Merit in 1946 for his work as Commanding Officer of the Aeronautical Chart Service and was awarded the Department of Interior's gold medal for distinguished service on May 26, 1949.

# Scientific and Cultural Cooperation Program

*By* HALDORE HANSON

EXECUTIVE DIRECTOR, INTERDEPARTMENTAL COMMITTEE ON SCIENTIFIC AND CULTURAL COOPERATION, DEPARTMENT OF STATE

I SELDOM HEAR a joke about map makers; apparently men of your profession make few mistakes.

One of the few that I have heard was told by General Joe Stilwell when he was military attaché in China. It seems that some 47 years ago the European powers were preparing to carve up China after the Boxer uprising, and each of their armies had sent out a mapping team to prepare maps of the areas they were prepared politically to take over.

This story is about the German team which was working in Shantung province. The German army, like the other European armies, had very few men who spoke Chinese; so they took a large crew, trained them to ask a few questions and to recognize a few answers in Chinese and sent them out into the countryside to get the names of the villages and measure the distances.

When the first data arrived in Berlin and they began putting it on a map they found there were hundreds of villages with the same name. It was Pu Ming Pai. The army couldn't figure that one out. They thought it might be a common name like Mud Lake, or Milltown, or something of that sort.

They asked the Chinese in Berlin, but nobody could tell them. They sent word back to Shantung and said, "Better check again on some of those towns."

The second time, they took some Chinese students to help them interpret and they found that Pu Ming Pai was a local expression for, "I don't understand you."

I am here to tell you how the State Department became interested in mapping activities, what it has done, and why it is doing it.

About 11 years ago, just after the Munich crisis, President Roosevelt called a Cabinet meeting to discuss how the United States could develop closer relations with both the governments and the peoples of the other American Republics. We were greatly concerned at that time because the German and Italian Governments were carrying on activities with which our diplomatic relations could not cope.

The Germans not only had their economic enterprises in the form of air lines and other transportation companies, they had schools and book translations and scholarships and a variety of other ways of dealing directly with the peoples of Latin America. They also had a variety of missions—military, naval, air, engineering—any type which they felt would give them a better working relationship with those governments.

As a result of the Cabinet meeting, called by President Roosevelt just after the Munich crisis, the U. S. Government said it would offer to the other American Republics any type of technician they wanted to borrow from our Government. The initiative to ask for him was up to them. We were willing to give them agriculturists, public health doctors, engineers, geologists, and, of course, map makers.

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We were trying, however, to make clear to those governments that we were not motivated by either imperialism or espionage. So we gave to the other American Republics the right to plan this program, and we also offered to them a training program in the United States that would prepare their technicians to replace ours as soon as possible and to put their national services on their own feet.

That was the kind of offer we made to the governments in 1939 after Congress authorized the program.

In the past 10 years we have sent to those 20 Republics 1,700 U. S. Government technicians, and we have brought here 2,200 of their young technicians for training.

On my recent trip I talked and heard stories about scores of these men in each country who almost immediately after returning to their governments had been appointed chiefs of bureaus, directors of laboratories, or directors of various scientific services.

There is no question but that a very high percentage of these men have benefited greatly by the training, and that the governments themselves are making use of their services on their return.

This group, I imagine, is particularly interested in knowing what we have done in the field of mapping. In 1944 the State Department asked the Coast and Geodetic Survey to set up a special training course for Latin Americans. In the last 5 years the Coast and Geodetic Survey has brought here with State Department funds 88 technicians from 15 different countries.

The training lasts from 3 to 8 months, depending upon the subject matter and the needs of the individual. The courses are in geodetic surveying, hydrographic surveying, map and chart production, and related subjects.

Some men who have gone back from this training have risen almost immediately to top positions in their governments. I was told the other day, for example, that the head of military geography in Ecuador is a graduate of this training; and only this week a recent graduate was appointed officer in charge of military geography in Colombia.

Of course, going on down the list of the various specialized mapping services in the governments, we find that many of the 88 who have returned are now in those jobs.

The person in charge of this training for the Coast and Geodetic Survey is the chairman of your Annual Meeting, Mr. Murray Poling. I think in the eyes of the State Department he has conducted one of the finest training courses that we have in Washington for foreign technicians. It is always nice to say something like that at a meeting such as this, but I really mean it about Mr. Poling.

I do not think I need stress the selfish motives that the United States and the other governments have in contributing money to this project. Actually, the other governments have contributed on an average of two dollars for every one the United States has put in. That is understandable because of the direct benefits their government services are receiving.

I think our first selfish motive is the realization that good maps contribute to better transportation, to better development of national resources, and to a variety of other fields which increase economic growth. We in the United States know, as do the people in those countries, that economic growth is an interde-

pendent asset that flows across national boundaries, and that the United States, as well as neighboring countries, is benefited from such development.

On my trip I heard several appeals for better map services from some of our other projects. Our census people were having trouble for want of better maps, and those in the Public Roads Administration, the agricultural surveys that we were conducting, and the water surveys were all asking for better maps. So we are not getting this from just the people who are self-interested in maps, but from those who realize that maps are the tools on which they depend.

A second selfish motive, which is not calculated but is an inevitable result, is an increase in foreign trade. It has been estimated that the particular 88 trainees we had here in the field of mapping have been responsible for the purchase of United States equipment worth four times the amount of money that the United States put into their training.

The most important consideration of the State Department is that these men, after they have been training in the United States for a period of months, are our friends, both as professional colleagues and as men who have seen and understood the political methods of the United States.

I should mention the mapping activities of agencies other than the Coast and Geodetic Survey. The Census Bureau, in cooperation with four other statistical bureaus of our Government, is getting ready for the 1950 census of the Americas. This is to be the most comprehensive single census ever taken in the Western Hemisphere.

Beginning about 1947, the Census Bureau has been bringing 40 or 50 geographers and statisticians from the other American Republics each year for a long training course in census methods. Only a minimum of 12 days' training in each of these courses is given to map making, or to map-making activities, because these men are not being trained as cartographers, but rather to read maps and to supervise cartographers who are working on the census projects. On the whole, these are top census officials who must be able to understand all steps in the national census.

During this same period of time, the Census Bureau had four of its top geographers in Latin America moving from country to country on assignments of perhaps 6 to 9 months duration, discussing the 1950 census with those governments.

Another agency that has done a substantial amount of cooperative work in the field of mapping is the U. S. Geological Survey. During the last 10 years it has had 20 of its best geologists working on strategic minerals and other commodities of local importance in Latin America for those governments. We have cooperated in the completion of the mapping of primary strategic materials in more than 10 of the Latin American countries. The maps we turn out jointly are published both in English and the local language and are available to the public in both countries.

The Geological Survey, like the Coast and Geodetic Survey, has a training course here in Washington which combines university work and practical experience.

And finally, the Public Roads Administration, which has offices in five or six countries in Latin America, and the Civil Aeronautics Administration, which has field parties in seven countries, are doing some work in the field of mapping.

These agencies also conduct training work in Washington in which map making is a subordinate part.

So, all told, there are five U.S. Government agencies under the State Department program that have an interest in cartographic training. The Coast and Geodetic Survey is the primary agency in that field.

This Latin American program which I have described—and which is a relatively small one—is a forerunner of President Truman's "Point Four" program. He has several times cited this as one of the programs that he intended to expand under his "Point Four" program. In fact, the office which I represent here is being transferred into the "Point Four" administration of the new program.

Under that program President Truman said he would raise technical assistance to underdeveloped countries to the level of a major national policy and would make such assistance available to any government that was prepared to make good use of outside technical help. By "good use" we generally mean that the other government be prepared to expend a major part of its own efforts, its own personnel, and its own funds on any project of national development and that we provide the foreign "know-how."

This program is largely instructional and advisory, depending largely on the money of the other government to carry out the ideas. Occasionally, we find, in our own national interest, that it is desirable to put into a foreign project a larger share of our own money, our own personnel, and our own equipment to get the job done.

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## Educational Steps in Point Four Program

THE POINT FOUR program must include an education effort as bold, new, and imaginative as the technical assistance effort, a commission of the National Education Association warned in a report issued in Washington.

New and strange elements will be introduced into the cultures of other nations, the experts observed. Not only the ways but also the ends and values of life will be affected.

"The clear purpose of the program," the Educational Policies Commission report says, "should be to assist the people of each participating country to improve their condition." We must avoid even the suggestion of exploitation of the weak, of "dollar diplomacy," of "cultural imperialism." We must avoid imposing through economic pressure a way of life or a political philosophy.

It was recommended that the educational program embrace non-school as well as school agencies. All Americans participating should receive special preparation for their duties. The "rich ethnic resources" of America should be fully utilized, the report advised, recommending that talent present in our Negro citizens be sought out in working with technically undeveloped peoples, the majority of whom belong to the colored races.

Specialists of other countries should be trained in the United States, and selected young men and women should study our development of industrial civilization.

The American people must be prepared for a long and sustained effort, the educators warned.

The colonial peoples are rising, the report said in arguing for the Point Four program. Approximately two-thirds of the people of the earth are caught in a vicious circle of ignorance, poverty, disease, and hunger. Nevertheless, a life of economic security and well-being is technically possible for all men.—*Science News Letter,* July 22, 1950.

# The Surveyor, Pioneer to Professional

*By* W. B. WILLIAMS

PRESIDENT, MICHIGAN SOCIETY OF REGISTERED LAND SURVEYORS

I BRING YOU greetings of the Michigan Society of Registered Land Surveyors, a group of some 115 men and 1 woman, engaged in the practice of our profession. The organization is only 7 years old but is an active youngster, as 7-year-olds usually are. Curiously enough it originated among the membership of the Michigan Engineering Society, which was organized in 1870 by the land surveyors of the State. The programs of the early meetings of the Michigan Engineering Society dealt almost entirely with surveying problems, but as the engineering field broadened, so of necessity did their programs and an M.E.S. convention today offers very little of technical interest to any engineer. One might say that the program has been broadened so much that it has flattened out, and attendance at the M.E.S. conventions shows it. I should like to compliment the American Congress on Surveying and Mapping on adopting the seminar plan of program for its technical sessions and to suggest respectfully, as becomes a freshman, that more time be devoted to technical sessions. There is something in the human constitution that is stimulated by discussion, but bored with elocution. I shall try to remember this 30 minutes from now.

## ORIGINAL LAND SURVEYS IN MICHIGAN

This paper must of necessity deal with surveying in Michigan, because my experience has been limited to practice in this one State. But I believe that in general the surveying history of Michigan is substantially the same as that of the other 35 states surveyed by the General Land Office (now designated Bureau of Land Management) into sections and townships. To those of our confreres who practice in the Thirteen Original States, I can only express my sincere sympathy and apologies for not being better acquainted with their problems. Their descriptions, I understand, start in most cases on highway centerlines, a certain distance from an intersection and then proceed on bearings. We have a few of these. One in Kent County reads: "Commencing on the centerline of the Fallasburg Road opposite the west edge of the Baptist Church parsonage as it was in 1857 or before the west wing was built thereon . . ." That last word makes it a "legal" description, but it doesn't tell us where the Baptist Church parsonage without its west wing was located. I trust that the good parson who occupied it did not in the life hereafter meet the same fate as his dwelling, for that burned to the ground sometime in the eighties.

Such descriptions, however, cannot be charged to the General Land Office surveyors who from 1805 to 1860 laid out the State of Michigan in theoretical square miles. They were a hardy crew pushing out into the virgin wilderness, wading swamps and rivers, hacking their way through cedar and tamarack swamps, packing in their grub, fighting the fever and ague, and on more than one occasion being forced to abandon their work and retreat to the nearest habitation by their archenemy, the mosquitos. Their instruments were the compass, the chain, and the axe; their transportation was their own two legs; and their pay prior to about

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1840 was $3 per mile of line for a party of six or eight men, the number depending on whether they had the luxury of a cook and a packer or performed these tasks themselves. In retrospect we can imagine that they must have been thrilled by the immense stands of virgin pines, the beautiful inland lakes for which Michigan is noted, and the vast sand dunes along the coast of the Great Lakes; but I doubt it. They probably had a viewpoint similar to that of Ned Shaw, my first party chief. I remarked one day about the beauty of the shrubbery on a certain lot. "Well," he said, "it may be shrubbery to you, but it's just brush to me. How in hell can you put a line through it?"

Who were these early surveyors and what were their backgrounds? Most of them had worked on the General Land Office surveys of Ohio and Indiana or with surveyors in the East. John Mullett, however, was a tailor who liked mathematics better than textiles and taught himself the art of surveying. William Burt, probably the most famous of them all, started as a merchant in Buffalo, N. Y., and likewise drifted into surveying through his interest in mathematics. Besides being an expert woodsman, he was a scholar and scientist; he delved into astronomy and geology, investigating the amount that a chain varied in length due to temperature changes and inventing the Burt Solar compass, which, though slightly modified, is still in use. Another, Lucius Lyon, who came from Vermont, later became Surveyor General of the United States. Some of them surveyed thousands of miles of lines; others only a few. Some did their work very accurately, according to the standards of the day; others deliberately falsified their notes, never even going on the land at all. But at the prescribed rate of $3 a mile I doubt if any of them, except those who speculated in land, became wealthy, although Lyon boasted in 1838 that he had on one contract averaged "a fraction over eight miles per day," which gave him the princely sum of $25 with which to pay and feed his crew. Of course they didn't have to pay income, outgo, while-you-got-it, or any of the other taxes that we have today; so a dollar was worth much more. Eggs were a nickel a dozen and whiskey was a dollar a gallon; and one did not need at least one car, a couple of radios, and a television set in order to keep up with the Jonses.

However, in some respects these pioneer surveyors of a century ago were in a predicament similar to that of their descendants of today. Then, as now, due to a lack of organization and to the general impression that anyone who could in any way acquire a compass and chain *certainly* knew how to use them, the incompetent and casual practitioner beat down the fees and brought disrepute on the whole profession. Actually it was not a profession in those days. With all due respect for their fortitude and industry, they were not called upon to exercise judgment and discretion or to express opinions as to the location of property lines. Their work was somewhat comparable to that of the instrumentman of today who lays out a highway, water main, or sewer from plans prepared by others or, more typically, one who stakes out the lots of a subdivision after its boundaries have been established by a surveyor. They were strictly technicians, and that impression has quite generally prevailed to the present day. How many times do we hear it said that "surveying is an exact science"? My father was once interrogated on this point on the witness stand and his reply, to my way of thinking, was perfect. He said, "No, it can't be, Mr. Counselor. Surveying is based on law, and you surely know how inexact that is."

Many of these deputy United States land surveyors stayed on and settled in this new frontier that they had opened. Their services were in demand by the

settlers and, to a slight extent, by the lumbermen, although the latter did not bother too much about property lines. Most of them preferred *not* to know anything about lines and to depend on pike pole, peavey, and caulked shoes, rather than the courts, to settle any argument. But the settlers were different; they *wanted* to know where their lines were located and who could tell them better than someone who had worked on the original survey? It mattered little about their position on the survey party as long as they had been on it. As years went on, these veterans became older, and so the tradition developed that any *good* surveyor *must* be an old man.

There was not enough surveying demand to enable this pioneer surveyor to make a living, so he generally had a farm and did the surveying in his free time and what he took in from this source was all "velvet." Therefore, he was satisfied with a modest fee which, without a doubt, was further influenced by his memory of the $3-a-mile fee paid for the original survey. So the second tradition, that a surveyor worked cheaply, came into being.

He maintained no office; he kept few notes and was very jealous about those that he did keep. In fact, I know of some cases in which the stakes were deliberately and consistently offset from the true corner at odd distances so as to confuse any other surveyor who tried to use them. Some of the old-timers got their greatest pleasure in life from showing up any other surveyor who had the temerity to operate in what they considered their territory. So the tradition was born that no two surveyors ever agree.

He still used the compass and chain, probably patched with wire, that he used on the original survey and picked up his helpers when he reached the job. Even today we occasionally have someone from the rural areas ask us how many helpers we want him to furnish besides himself, or we will get a telephone call something like this, "Say, will you send a man out to survey my lot? I've got some iron stakes and I'll drive them for him." We patiently explain that at least two of our men are required to make a survey and that they carry a carload of equipment. But the tradition is there and I am sure that it comes down from our forebears. In fact, I know some old-time surveyors who even today depend entirely on casual help. And over on the east side of the State, I have been told of at least two cases in which men are making lot surveys without *any* help.

The composite picture of the ideal land surveyor that developed in the mind of the public in these early days was (and to some extent still is) that of a man of about 60 who still had the constitution of an 18-year old so that he could cover a lot of miles in a day; who had an instrument that showed him where to find or place the corner stakes; who had a steel tape with which he could measure to hundredths of a foot, no matter who was holding the other end of it; who required a certain amount of oversight in his work because he was a simple-minded sort of person, or he would charge more for his time; who remembered all the surveys he made and could go up to any section corner or property corner he had surveyed and shoot a slug of tobacco juice at the exact spot where the stake was buried; and yet, one whose word was final in regard to the location of any property corners which he set until another surveyor questioned it, and then they were both crazy bums.

### FIRST MICHIGAN SURVEYORS' ORGANIZATION

It was this situation that prompted Hodgman, Skeels, Muenscher, Hubbell, and others, to organize the Michigan Association of Surveyors and Engineers in

1870 (later became Michigan Engineering Society), some 40 years after the southern half of the lower peninsula was first surveyed in an attempt to bring some order out of the chaos that was developing. Hodgman wrote what I believe is one of the first textbooks on land surveying that incorporated citations of legal decisions. Dean Cooley of the Michigan Supreme Court, appearing before the Michigan Association of Surveyors and Engineers in 1880, delivered his famous speech on "The Judicial Functions of the Surveyor." The courts began to inquire as to whether a witness was a member of this Association. The surveyor began to acquire professional standing. But he let his status slip when he began to tack on the title of engineer and became known under the dual title, which somehow seemed to carry more prestige. Personally, I am one of those rare members of the engineering profession who is an engineer by education and a land surveyor by training and choice. I have three pieces of paper which tell the world that I'm a civil engineer, but only one proves I'm a land surveyor. Although I've followed both professions, by far the major part of my work has been in the latter, which is the one I most enjoy. In fact I operate in reverse from most practicing civil engineers—surveying is my primary profession but I do some civil engineering on the side. The two complement each other rather nicely as it has been my experience that during those periods in the economic cycle when land surveying is slack, there is generally municipal engineering work to be done. But in our organization we never lose sight of the fact that the foundation of our business is surveying and mapping, which, in the assigning of personnel, gets priority over engineering work.

## RESURVEYS REQUIRE PROFESSIONAL JUDGMENT

Let us go back to consider for a moment the requirement for judgment and discretion which first arose soon after the original survey, when the settlers and lumbermen began removing the witness trees which had been marked by the deputy United States surveyors and the green softwood stakes which they had set began to rot. These pioneer conditions still prevail in the northern part of the State of Michigan. Some of the witness trees are still standing, and in many cases it is possible to find the stumps or roots of those which have been cut, and by allowing for the growth of the tree between the time of the original survey and the date when the area was "timbered off," a fairly accurate location can be made of the corner stake. Then, if the soil is light, some careful work with a shovel will disclose a stain in the soil that, as one goes deeper, assumes the definite form of the squared stake, which near the lower point may even yield a few shreds of wood. Finding such evidence brings the same thrill to me that I imagine an archeologist feels when he discovers a piece of ancient pottery or primitive artifact. In these localities a knowledge of woods, a strong back, and a keen mind are most essential to a land surveyor. He must satisfy himself beyond all reasonable doubt that he has exhausted all possibilities of finding the original stake before he proceeds to relocate the corner in accordance with the rules of the Bureau of Land Management.

In the more densely settled portions of the State, section-line highways and cultivation of the land have pretty generally removed all original corners and references to them. In these areas we rarely refer to the original field notes except to learn the length of the so-called fractional sections along the west and north sides of the townships. We rely exclusively on markers of various kinds and descriptions that have been set by surveyors in the past. Frankly, many

times we could not prove beyond a reasonable doubt that these are perpetuations of the original markers, but to attempt to retrace the original survey in the manner prescribed by the Bureau of Land Management would cause so much confusion in establishing property lines that we rely on these old markers; and by continued usage, establish them. For the same reason, we also rely almost exclusively on the evidence of lines of possession in relocating lost section and quarter corners rather than on the rules laid down by the Bureau of Land Management. I wish to make it clear, however, that we accept these markers and other evidence only for location of section and quarter corners. We locate interior lines according to the rules for subdivision of a section. In other words, we act as judge and jury, evaluate the evidence, and make our determination as to where in our opinion the property lines are located. If another surveyor has a different opinion, there may be a lawsuit and a judge will render an opinion reversing one of us. He in turn may be reversed by a higher court, however. So, in effect, a land surveyor is the judge of a primary court dealing with property lines, who operates without the benefit or specific sanction of legislation in about the same manner as the procedure in Canada outlined by Mr. Lindsay in his very fine paper at yesterday's session. There is one exception; our fees are not collected for us before the court opens our sealed reports.

## MODERN LAND SURVEY PRACTICES

Land surveying today not only deals with running lines between section corners and subdividing sections, as in the early days, but in a greater degree consists of attempting to locate on the face of the earth a certain parcel of land described in a legal document. Too many of these descriptions were drawn up by people far less fitted to prepare descriptions than even our least competent colleagues are to survey them. In our office we generally take the position that the client must furnish us with a description and that our duty is to show him where that described tract is located on the ground, together with any evidences of occupation that are at variance with it. This is satisfactory for lots in recorded plats and regular subdivisions of sections, but when it comes to the "metes and bounds" descriptions, we frequently find ourselves in the same position as you gentlemen here in the East.

If I may be personal for a moment I should like to say that we are fortunate enough to have excellent relations with the abstract company. In fact we rebuilt a large part of their plant for them 12 years ago, and we have the full use of their records as they have of ours. When we find descriptions that are indefinite, inaccurate, or inconsistent with previous surveys of adjacent properties, we check the abstracts, acquaint our clients with our findings, and advise them to consult their attorney. We never advise them as to their rights in the matter, but we merely state the facts. Then when their attorney comes in, we go over the case with him and let him advise our mutual clients as to their rights. As a result of this policy we have the goodwill of the local Bar Association, and in our conferences with the attorneys we meet them as equals. Moreover, we enjoy a very nice clientage from the attorneys as consultants on abstract examinations and in the preparation of the more complicated legal descriptions. Aside from our work with the legal profession, we have done a great amount of work on tax-roll descriptions and completely revised the tax lists of three counties of the State during the thirties. This work gave us a wealth of experience in title searching and in the preparation of legal descriptions and helped to hold our organization together in those difficult times.

Another phase of our work that is of a professional nature is that concerned with subdivision design and consultation on subdivision development. This is, of course, extremely variable in volume from year to year, but so are certain phases of the work of all professional men. Immediately after the war, for example, the doctors were extremely busy with confinement cases, and the attorneys with divorces. Any surveyor who engages in subdivision work should make a serious study of subdivision design, because the street and lot arrangement, especially on rugged or rolling terrain, determines not only the value of the lots but the final appearance and safety of the community. For example: Streets should follow drainage lines, both for economy in sewer construction and to bring the building site above the street level; as many lot lines as possible should be made truly perpendicular to the street; streets should intersect at right angles even where it is necessary to make a curve in the minor street a short distance from the intersection; crossing of the major highways with local streets should be avoided or held to a minimum; on very rugged terrain, building sites should be selected first and road locations and lot sizes fixed afterwards; curved streets are preferable to those that angle every few hundred feet. "Elementary, my dear Watson," you say? Perhaps, but when I look over the plats recently recorded at our State Capitol, I frequently wonder if perhaps we shouldn't discuss some of these more elementary things at greater length in our technical meetings.

## SUMMARY

To summarize: The pioneer surveyors of 100 to 150 years ago have left us a legacy of fortitude and courage that is sadly needed today when all too many are thinking only of payday and security and find no pleasure nor even satisfaction in their work. Their successors left in the minds of the public certain traditions regarding the land surveyor that are hard to live down, but that is what must be done. All too many surveys have been, and still are being, made by engineers who are out of a job. Mutual admiration and condemnation of the public will not help. Our work today is definitely of professional status, but all too often our conduct is not. Our offices are slovenly; we are careless in personal appearance; our field equipment is not well kept up—in short we make no attempt to conduct ourselves as professional people should. "The fault, dear Brutus, is not in our stars, but in ourselves."

*Announcing*

The Eleventh Annual Meeting

JUNE 11, 12, 13, 1951

*Shoreham Hotel, Washington, D. C.*

# Pre-Sensitized Lithographic Plate

*By* ROBERT E. ROSSELL

CHIEF, PHOTO-LITHOGRAPHIC BRANCH, THE ENGINEER CENTER, FT. BELVOIR, VA.

MANY OF YOU who are familiar with the conventional and long, drawn-out process of making albumin plates for photo-offset reproduction have a surprise coming to you this afternoon.

When I tell you that it is now possible to completely process a lithographic plate and have it ready for the rolling presses within 3 minutes, some of you will not only raise an eyebrow in disbelief but will demand an on-the-spot demonstration.

Well, I am prepared to give that demonstration on this very platform today, after which I hope the eyebrows will assume their normal positions.

But first I would like to say that this new ultra high-speed lithographic plate has been developed—I should say invented—by the research staff of the Photo and Lithographic Branch at the Engineer Research and Development Laboratories, Fort Belvoir, Va. It became a reality while we were working on a research contract between the Keuffel & Esser Company and the Department of the Army.

Before actually demonstrating the new plate, from negative to printed sheet, I would like to briefly review the seven steps required in producing the conventional albumin plate so that you can compare this old process with the new. You will immediately see that five of the seven steps have been eliminated entirely.

First, in making the conventional plate, we begin by cleaning the metal. In the next step we sensitize it. Then we expose, usually with carbon arc lights, and after that we apply developing ink. We have already taken four steps, and our plate is still far from ready.

Finally, we develop, then etch, then gum—seven steps altogether.

Quite a process, isn't it? And consider, if you will, the time, equipment, labor, and personnel necessary to produce such a plate. It is not like this with the new process. Here we find it as simple as wiping chalk off a blackboard. Steps one, two, four, five and six have been entirely eliminated. Only two operations remain—to expose and gum—and the plate is ready for the press.

It is as simple as that—no cleaning, no coating, no developing, no washing, and no etching.

You will note that the new plate comes ready for use. It is *presensitized.* It can be handled in ordinary room light. No darkroom is necessary. It is coated with a slow-speed emulsion which does not fog immediately unless exposed to a strong light.

The plate itself is made of a cellulose acetate film, and though it is relatively costly, its cost can be reduced by lamination to a less expensive base material such as paper or metal foil. In fact, a strong base is recommended for the purpose of adding strength to the plate, because the acetate film itself lacks stability and the durable qualities of a metal plate.

Presented at Ninth Annual Meeting, American Congress on Surveying and Mapping, Washington, D.C., June 8–10, 1949.

I have emphasized speed in the preparation of the plate for the press. Let me give you an idea of how fast it can be done. Consider exposure.

Using a 30-ampere single-arc lamp 30 inches from the vacuum frame, exposure is completed within 20 to 30 seconds. Using a No. 2 reflector-type photoflood lamp, at 30 inches, exposure may be completed within 3 minutes.

As pointed out previously, the plate is made ready for printing in two simple operations—exposure and gumming. The sensitizing agent is water-soluble, but upon exposure to light it decomposes to form an insoluble hydrophobic material which repels water but attracts and carries the lithographic inks.

In the gumming operation, the unexposed, soluble portion of the sensitizing chemical is removed; the image is fixed and the non-printing areas are protected. That is the complete operation. The plate thus obtained is ready for the press with no further preparation.

For those of you who may wish a more technical description of the new plate, I will add that the surface of the acetate film is treated to provide a saponified layer which is hydrophilic or water-receptive, and thereby repels the lithographic inks. The nature of this saponified surface is such that it is capable of being coated or sensitized with a light sensitive diazo compound, the light decomposition product of which is able to tan the surface. Furthermore, the smooth surface of the film has the ability to carry sufficient moisture without the basic grain structure necessary in conventional plates. Thus, there is no breaking up of fine halftones or lines.

Although I have been emphasizing the advantages the new plate has over the old, I do not want to leave the impression that the former has been perfected to the nth degree. It has not reached that stage of perfection by any means. In fact, there are many kinks yet to be ironed out. However, we at the Engineer Research and Development Laboratories think we have something, and our experimental efforts are being directed toward the goal of perfecting a plate that will give the best possible results in the least amount of time and with a minimum of effort.

It is not difficult to see at this point how drastically the new acetate film plate differs from the conventional metal plate. But there are five more important features of the new plate that I would like to list here.

1. The presensitized plates reach the user in a manner similar to the way ordinary photographic paper is packed. When properly packaged, they may be stored under normal conditions for prolonged periods of time. Tests conducted in our Laboratories indicate that the plates are usable as long as a year after the coating is applied.

2. Humidity and temperature prevailing at the time of exposure have little effect upon the plate—so little, in fact, that they can be ignored for all practical purposes.

3. Grainers, whirlers, and sinks are eliminated and very little space is required for plate making when these new plates are used.

4. The surface of the acetate plate is inert in that it will not oxidize. This automatically eliminates protective gumming and etching. And, of course, it is much easier to handle.

5. Finally, the result is that our tests have proven that prints made on the press from this new plate are superior to prints made from metal plates. There is an absence of broken lines and halftone dots.

Will this new acetate plate revolutionize the lithographic printing industry? Who can tell? It is rather doubtful whether any person connected with lithographic research and development work, in either private industry or gov-

ernment, could predict where the next 5 or 10 years of scientific investigation will lead. But you or I need not possess the powers of a clairvoyant or a seer to foresee the possibilities that this new plate will ultimately bring to the lithographic printing industry.

Think what the development of this presensitized plate will mean to an army in wartime in providing maps for its troops. A wartime army uses maps by the ton. With this new plate, it may be possible to provide more maps, possessing more detail, in less than half the time it takes to reproduce the maps from the conventional plate. Maps can increase the effectiveness of the individual soldier as well as the mobility and effectiveness of the armed forces as a whole.

The new plate will also assume an important role in industry and education and in every human endeavor in which the printed word plays a vital part. As to what it can do for the so-called man-in-the-street, and for all people everywhere in the field of publishing, I leave to your imagination.

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## "Airborne" Offset Lithographic Press

MAP-REPRODUCING PRESSES, and not just the maps themselves, will be at the actual scene of activity if or when this country goes to war again, say lithographic experts at the Army's Engineer Research and Development Laboratories.

A pilot model of a new "airborne" offset lithographic press, designed at the Engineer Labs and built by the American Type Founders Corp., is now completing initial tests prior to trials by troop units in the field. It can be flown to a desired area, removed, and set up for operation in a fraction of the time required for transportation by sea or land.

Simplicity, portability, and a built-in ability to withstand changing conditions of rough and rapid transportation have been taken into consideration in the design of the press. Equipped with hangars or adapters by which the whole unit may be lifted, the press is also fitted with four wheels so that it may be moved without dismantling. Four small screw lifts enable it to be leveled and immobilized in position.

Both smaller and lighter than the Big Chief of World War II fame, the new press measures 59¼ inches in height compared with the 72½ inches of the old model. Its center of gravity is correspondingly lower also. Length is 72 inches against 89 inches. Weight has been reduced from 6600 pounds to 4200 pounds. Part of the lightening process was accomplished by the substitution of three hollow cylinders for the solid type heretofore used. Principal weight reduction was accomplished, however, by the use of ¼-inch welded steel plate in a unitized base and side-frame construction in place of heavy castings.

Some space saving was effected by reduction of the delivery stack by about one-third, the feed-in stack being kept the same size. Inking rollers have been reduced from 18 to 14. The water fountain systems of both models are substantially the same. Military maps, charts, line and half-tone work up to 22 by 29 inches in size, in single or multicolor (by successive printings) in hairline register, are possible with the press. Speed of reproduction is variable from 3000 to 5000 sheets per hour and is controlled by a V-type speed control.—*Technical Data Digest*, August 1, 1950.

# The New City Survey of Budapest

*By* DR. ALEXANDER TARICS

THE RESULTS of a modern city survey provide an essential foundation for the execution of engineering work related to the management of a big city. Basic data obtained and accurate maps prepared from this type of survey are needed for general and detailed city planning: the subdivision of lots in accordance with the city plan; detailed planning and layout of municipal engineering projects (streets, sewers, water system, etc.); and the recording of continuous changes in boundary lines, buildings, and public utilities.

When designing a new engineering project in a city area, existing conditions should be taken as the starting point, and the new work should fit into those conditions. Serious difficulties are often encountered during construction if up-to-date city survey information is not available at the time of planning. This idea finds expression in the following statement, quoted from a publication of the American Society of Civil Engineers: "Money saved in engineering or planning is frequently lost many times over in ill-advised construction."

## WHY A NEW CITY SURVEY?

The first survey of Budapest was made in the 1870's. This survey, which adequately fulfilled the needs of those times, had two basic imperfections from the point of view of modern requirements.

First, the survey was made by the plane-table method and accuracy of the costly work could be preserved only on the original maps, which were pasted on glass plates to prevent distortion on the paper. Injury and deterioration of the maps from use and age result in their reduced usefulness and their life span is limited. As a source of technical data (dimensions of lots, streets, etc.), only the original maps are of real value because the duplicate copies contain considerable distortions, even if made with the utmost care.

At Budapest, the aspect changed as the city developed. Some lots were subdivided; others were combined; old streets were adjusted; new streets and buildings were constructed. These changes could not be incorporated on the old maps with an accuracy in keeping with the high value of the property involved and, consequently, the original maps were not revised. The scales of the maps are 1:720 in the interior of the city and 1:1,440 in the outlying areas, and the accuracy of map data is limited by the scale and drafting precision.

The majority of the control points established by the old survey to serve as a basis for the mapping of details were not marked permanently and those destroyed were never restored. Consequently, it was necessary to lay out new streets, boundary lines, and buildings on the basis of new control points established for the purpose from time to time as the need arose, and these new control points did not fit into the control network of the original city survey with satisfactory accuracy.

Inaccuracies and lack of dependability in data obtained from the maps and those inherent in the determination of the necessary control points are manifest

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Before coming to the United States, Dr. Tarics was a professor of surveying at the Technical University at Budapest and formerly the chief engineer of the New City Survey. He is now lecturing on Civil Engineering at the Indiana Technical College, Fort Wayne, Indiana.

in the shapes and positions of lots laid out and in the difficulties encountered in making surveys for engineering projects. With the passing of time, increasing discrepancies developed between the maps and actual conditions on the ground, and difficulties involved in the solution of city planning problems were multiplied.

Repeated use of the original maps in connection with lot and building layout work made them very soiled and worn. They became almost unusable in areas where development and activity were greatest and where they were most needed.

The second deficiency of the old survey resulted from its being mainly a horizontal survey; even the control leveling was extended over only a small section of the city. Vertical survey data necessary for municipal planning and for use in the design and construction of public utilities were lacking altogether.

In dealing with the engineering problems related to administration of the city's affairs, difficulties arose in an ever-increasing degree because the results of the old city survey became obsolete and unreliable.

Although the need for a new city survey was recognized about 1900, a period of 30 years was required to educate the lay members of the city council to the value of it. An ordinance passed in 1932 authorized a new survey of Budapest. In 1937 a public law made a city survey compulsory for all cities in Hungary.

Before the new city survey actually got under way, extensive investigations were made concerning city surveys made in foreign countries, especially in Switzerland, Finland, and Germany. A basic plan for the new survey and technical procedures to be followed were also established.

The greater share of the surveying was contracted to private engineers by the municipality. The Office of City Survey—an organ created for the execution of the plans—in addition to contracting, supervising, and receiving the work, had as its main responsibility the continuous improvement of techniques. This is a most important function, since certain almost identical operations are repeated many thousands of times within the individual phases of the survey. Therefore, the smallest simplification or innovation might very considerably decrease the amount of work to be performed.

## THE BASIC PRINCIPLES OF THE NEW CITY SURVEY

The execution of the new city survey has been planned to avoid the shortcomings of the previous survey and to satisfy all foreseeable requirements of the work.

Instead of depending upon graphical representation on a map for preservation of results, as in the past, systematically arranged files of sketches, computation records, and lists of coordinates are now maintained. The coordinates of all the corners of property boundary lines are computed on a rectangular plane coordinate system and recorded in special lists. Although a map is also made, it is considered only as a general delineation of the survey results, a pictorial summary of the data, made for a definite purpose.

This method of preserving the results of the survey makes possible the fullest utilization of the accurate detail measurements for subsequent uses. The utilization is not limited by the scale of the map. From the data thus compiled and preserved a reliable map of any scale can be plotted. Thus, even if the original sheets are ruined or deteriorate, the results of the survey, made at considerable expense, do not become worthless.

The survey records preserve the status of the city as it was at the time of the

survey. The city, however, is changing continuously. If the changes were not registered in the records, the discrepancy between the survey data and actual conditions would become increasingly wider and, finally, the survey would lose its value altogether. Therefore, changes are surveyed and records of the results are attached to those of the original city survey.

Incorporation of the changes into the results of the original survey is made possible by the network of permanently marked control points of adequate density which forms the foundation for the whole city survey. The first steps in the control survey procedure are the permanent marking of this network and the determination of the position of its points in relation to one another and to the coordinate system, by means of field measurement and calculation. Revision surveys are also tied into this network of control points, which is a fixed framework.

A city survey executed according to these principles is of lasting value if adequate attention is paid to the surveying and recording of changes. Such a survey need never be repeated.

The new city survey includes the determination of elevations, and therefore offers a perfect basis for city planning and for the design and construction of engineering projects (roads, streets, sewers, etc.).

In the previous survey of Budapest the so-called Vienna Fathom (1 Vienna Fathom = 1.896 meters) was used as the unit of measurement. The new survey makes possible a change from this cumbersome old system to the metric system.

## TRIANGULATION, TRAVERSING, CONTROL LEVELING

The triangulation network of the city survey consists of 1,810 permanently marked control points, spaced about 400 meters apart in the inner section of the city and about 500 meters apart in the outlying sections. The triangulation was carried out on a "from the whole to the part" basis, in four classes containing 7, 17, 58, and 1,728 points, respectively.

The base line for the triangulation, located on an island in the Danube near Budapest, was measured in 1933 with a wire apparatus loaned by the Finnish Institute of Geodesy. The same instrument was also used in several other European cities (Tallinn, Potsdam, Riga, etc.).

The length of the base line is 3,576.31372 meters, with a mean error of $\pm$ 0.58 mm. (1:6,250,000).

One side of a closed central polygon 11.8 km. long has been developed from the base line through the base net.

After adjusting the observations, the mean lineal error in the different classes of triangulation was as follows:

| | |
|---|---|
| Base net | $\pm$ 1 : 770,000 or $\pm$ 1.3 mm. per kilometer |
| Central polygon | $\pm$ 1 : 667,000 or $\pm$ 1.5 mm. per kilometer |
| Second-class triangulation | $\pm$ 1 : 588,000 or $\pm$ 1.7 mm. per kilometer |
| Third-class triangulation | $\pm$ 1 : 455,000 or $\pm$ 2.2 mm. per kilometer |
| Fourth-class triangulation | $\pm$ 1 : 200,000 or $\pm$ 5.0 mm. per kilometer |

The coordinates of the triangulation points were computed on a rectangular plane coordinate system, with its origin near the center of the closed central polygon and its axes running from south to north and from west to east.

The network of control points established by triangulation would not assure the desired positional accuracy of detail features; therefore, the number of points was increased by traversing, so that the average distance between two control

Triangulation station in the inner section of city.

Triangulation station and wooden instrument tower.

points was reduced to approximately 100 meters. In this manner 17,000 traverse points were established and permanently marked between triangulation stations.

The traverse stations were usually set in the sidewalks in built-up areas, with the result that the street traffic did not interfere with measuring, and the permanency of the stations was much better ensured. The traverses were adjusted to the triangulation. The methods used and the limits of closure required were such that the mean lineal error should be less than $\pm$ 1/15,000. The actual errors of closure amounted to only 30 to 40 percent of this allowable limit.

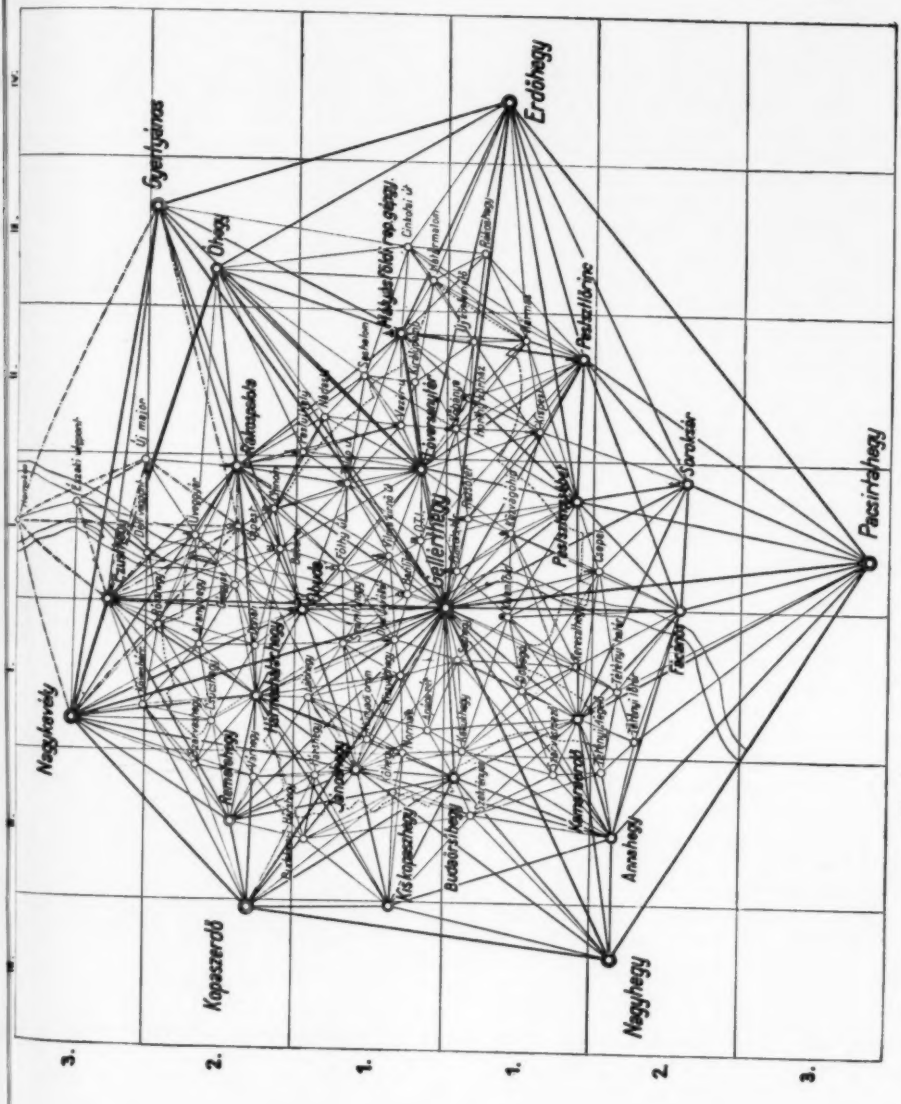
The foundation of the vertical control survey is a network of 1,980 bench marks determined by leveling in two classes:

The *first class* consists of 974 points which constitute 62 closed level circuits. These circuits cross the Danube at seven locations, five of which were run across bridges and two across the river. The observations were adjusted by the method of least squares, the mean error for the whole network being $\pm$ 0.456 mm. per kilometer, less than half of the $\pm$ 1.0 mm. allowable limit.

The *second class* of leveling, consisting of 1,006 bench marks, was set up so that in every circuit the starting and ending point was a bench mark for which the elevation had been established by first-class leveling. The second class of leveling was adjusted to the first. The limit of closure error was $\pm 1.5\sqrt{n}$ mm., in which "n" is the number of instrument positions.

### DETAIL HORIZONTAL AND VERTICAL SURVEYS

The detail horizontal surveys were intended for use in determining the shape and layout of engineering projects (streets, buildings, etc.) and property boundaries. The characteristic outlines of engineering projects are easily identifiable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Kis-kopaszhegy
Budakörshegy
Kamaraerdő
Annahegy
Farkashegy
Jánoshegy
Hármashatárhegy
Rómaihegy
Kálváriahegy
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Normafa
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on the spot, whereas boundary lines generally are not, except in the case of built-up areas of fenced-in properties. In many instances even the fences are not erected along the correct lines, because the data used in establishing the boundary lines were not accurate enough. Therefore, preceding the survey, the boundary lines of the individual properties (i.e. the corners of the boundary lines) are officially and permanently marked with concrete posts sunk into the earth, or with metal pegs placed in the sides of fences and buildings. In the course of this procedure, the boundaries between the properties are determined by the owners concerned, whereas those facing public thoroughfares are established by the city engineers. In controversial cases, or at the definite request of the owners, the boundary lines between lots are also determined by the city engineers. An official record is kept of this procedure and of agreements reached. The city engineer makes a sketch of the individual properties involved and of the blocks which these properties constitute. The sketch shows all corners of the boundary lines. In each administrative district the blocks are numbered, beginning with 1, and the corners of boundary lines within each block are also numbered in the same manner. This sketch serves as an outline for the detail horizontal survey.

After the marking of boundary lines has been completed, the next step is the detail horizontal survey, consisting of lateral measurements from base lines established from the horizontal control points. The lateral measurements are always taken at right angles to the base lines and it is necessary to have a base line no farther than 20 meters from details to be located. All the details inside the blocks therefore cannot be surveyed from the base lines, and auxiliary control points must be established, chiefly by traversing. These points are marked with temporary wooden stakes. Auxiliary traverse or triangulation control points established are also marked with wooden stakes.

In turning off right angles from the base lines for the lateral measurements, a simple hand instrument containing twin glass prisms is used. The horizontal measurements to details are made with steel tapes.

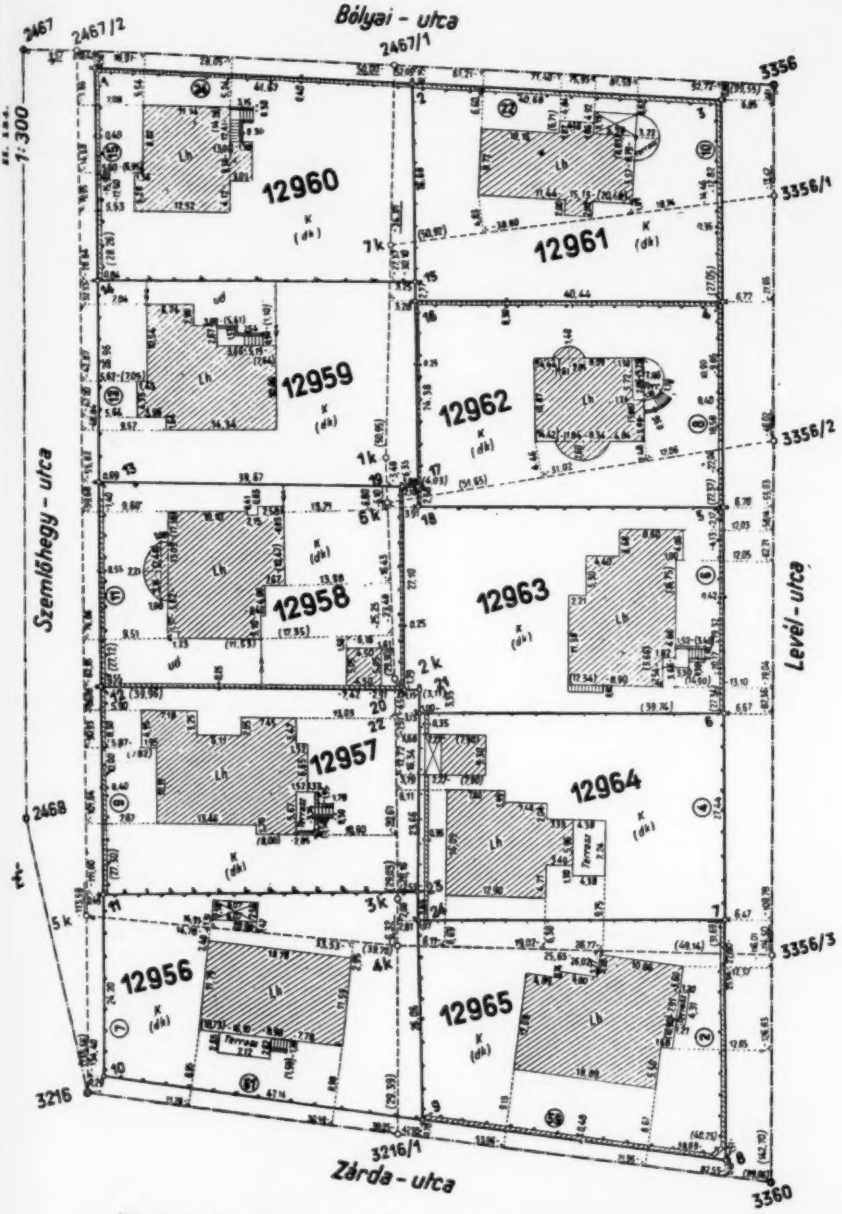
The results of the survey, including all numerical data, are shown on charts drawn on translucent paper, each individual block separately, and with measurements lettered in black Chinese ink. These drawings are called block charts; their scales are 1 : 500, 1 : 300, or 1 : 200, depending on the density of details in the blocks.

The coordinates of all boundary corners are computed on the rectangular plane coordinate system previously referred to, the coordinate values being computed to the nearest centimeter, that is, to two decimal places.

The determination of these coordinates for the Budapest survey requires a considerable amount of calculation as a total of about 250,000 coordinate-pairs will have to be computed. Methods of calculation developed and the use of special calculating machines simplify the work to a large extent.

The mapping is being done on a scale of 1 : 1,000 on 70 cm. by 90 cm. quality drawing paper pasted on 1-mm.-thick aluminum plates. The complete map of Budapest is 22 meters by 18 meters in size and consists of 494 sheets.

Since map details are being located by rectangular offsets, simple rectangular rulers are used for the plotting. The plotting is done as accurately as possible, the required accuracy being 0.1 mm., the equivalent of 10 cm. in the field. The dependability of measurements on the map is comparable. Pencil lines drawn on the map are covered with black Chinese ink lines 0.06 mm. wide.




Block chart showing the results of the horizontal survey.

The original drawings are photographed on glass plates. Sensitized aluminum plates are then exposed to light through the negatives, after which the map sheets are printed from the aluminum plates by the offset method.

A separate 1:200 scale map is made of public thoroughfares.

After the completion of the survey, maps to scales of 1:5,000, 1:10,000 and 1:25,000 (wall-map size) are made for use in city planning.

When the 1:1,000 scale maps are ready, computations are made of the areas of individual lots. This work is simple and accurate because the coordinates of the boundary corners have been computed previously and are used in the area computations. The method offers an excellent opportunity for an accurate check.

Detail of the 1:1,000 scale map with contour lines. Dotted lines show the outlines of future streets.

Concurrently with the area computations, the areas of the different classes of actual cultivation within each individual lot (built-up area, garden, courtyard, orchard, etc.) are determined with a precision planimeter. The data thus arrived at form the basis of the reclassification of real property for taxation. The areas of the individual lots, as recorded in the land register, are then corrected on the basis of the results of the area computation of the new survey.

The next step is the detail vertical survey. The area of the city of Budapest has been divided into three belts for this purpose.

The *first belt* consists of the outer region of the hilly parts of Buda. A contour map will be made of this area by aerial photography.

The *second belt* is the inner region of the hilly sections of Buda which are less densely built up and where the greatest development can be expected. A contour map with contour intervals of 0.5, 1, or 2 meters, depending on the inclination of the ground surface, is made of this belt by tacheometry.

The tacheometer gives the horizontal distances and the heights directly without the usual laborious computations. In tacheometry, the prescribed accuracy requires that the height of any point of the terrain obtained from the contour map deviate not more than 20 cm. from the height obtainable on the basis of an independent method, i.e. by leveling.

The *third belt* comprises the built-up area of Buda, which is mainly flat, as well as the entire Pest side. Here, the height of the street axes is determined by leveling. Elevations obtained in this operation are accurate within a few millimeters.

The results of the vertical survey are recorded with black Chinese ink on blue-line copies of the 1:1,000 scale maps. Aluminum plates are then made of these maps for offset printing, as described previously. The aluminum plates record only the results of the vertical survey, because the blue lines of the horizontal survey do not photograph. Therefore, two aluminum plates are made of each sheet of the 1:1,000 scale map for offset printing: the first shows the results of the horizontal, and the second those of the vertical, survey. From these plates maps are printed which show the results of both surveys, the first in black and the second in brown color.

Before a new street is constructed, the coordinates of the intersections of the new street lines with existing boundary lines are computed and the intersection points are set, where possible, by tape measurements along the lines between boundary corners. Where this cannot be done due to some obstacle, the horizontal control points are utilized.

Changes in boundary lines (subdivisions, etc.), heretofore made graphically on maps, are now carried out by numerical computation based on the coordinates. Simple computation procedures were developed for the solution of different problems by computing machine methods and, therefore, not only engineers but auxiliary personnel have been employed, after appropriate training. The numerical method has the advantages that the results obtained by different individuals do not vary and the inaccuracies caused by distortions of the map material are eliminated. The use of this more accurate method of computation is justified by the value of properties in the inner sections of the city.

## PERCENT COST OF DIFFERENT PHASES OF WORK

On the basis of experience gained from surveys of Budapest and foreign cities, the costs of the different phases of the work, expressed in percentages, were estimated for the Budapest survey to be divided as follows:

| | *Percent* |
|---|---|
| Triangulation and control leveling | 6.9 |
| Traversing | 13.1 |
| Marking of boundary lines | 19.2 |
| Detail horizontal surveys | 38.4 |
| Mapping | 10.9 |
| Detail vertical surveys | 8.2 |
| Area computations and compilation of registers | 3.3 |
| Total | 100.0 |

The new city survey of Budapest will ensure the solution of many difficulties in administration, and plans were made immediately after the war for completing the project by the end of 1951.

# The First Modern Triangulation

*By* JACOB SKOP

CHIEF, MAP DESIGN BRANCH, ARMY MAP SERVICE

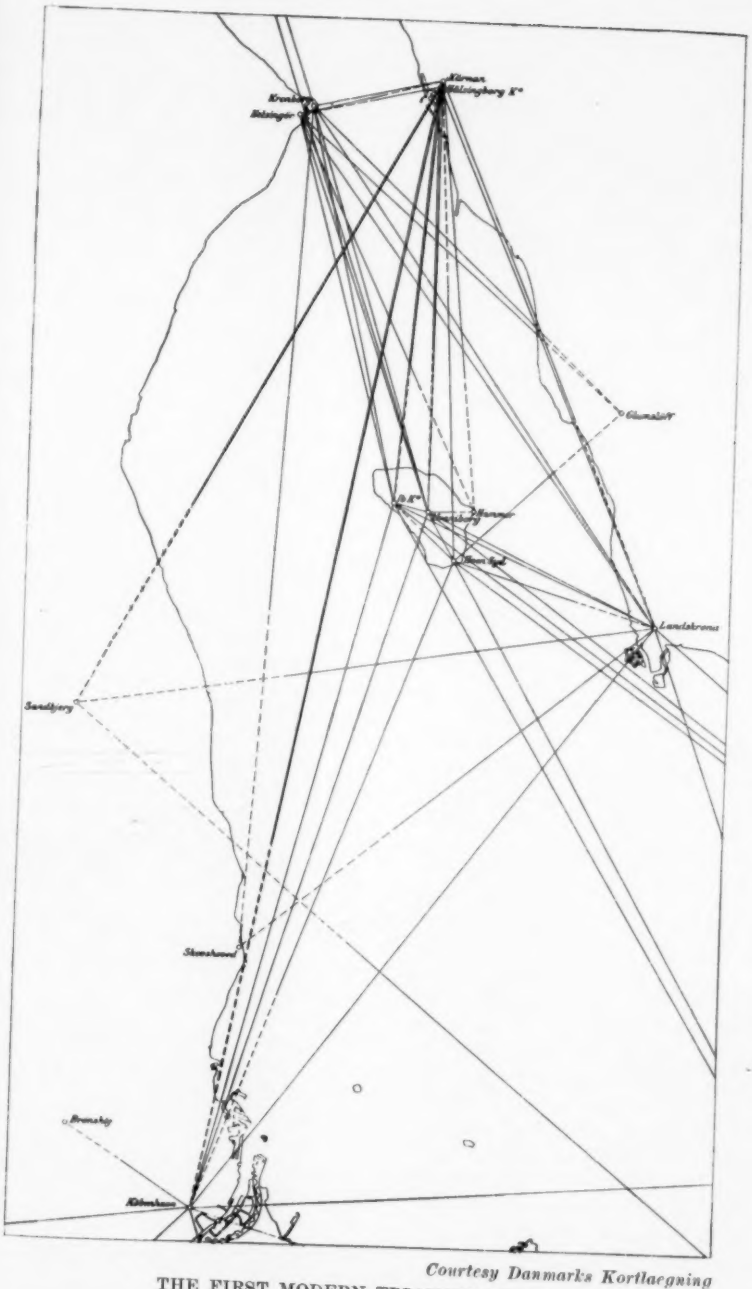
A GRAVE INJUSTICE committed against Tycho Brahe requires correction. Up to the end of the 15th century, cartography was largely a combination of art and imagination, with little of the scientific. The map makers of the Middle Ages were generally content with the rudimentary methods of their predecessors. Their maps, most of which were small in scale, promulgated the myths and fancies of the ages. True, the horizon of geographical knowledge had been considerably broadened by the rediscovery of the *Geographia* and the *Almagest* of Claudius Ptolemy and by the explorations of da Gama, Columbus, and their equally intrepid contemporaries and successors. But the methods of showing this information on maps were no more accurate than those used by Eratosthenes in 200 B.C., by Strabo in 25 B.C., or by Ptolemy in A.D. 150. It was deemed sufficient to show cities, islands, and points of land just somewhere in the general area of their correct location. True azimuths and distances between mapped features were unknown, and it was no rare thing on a small-scale map for a feature to be plotted 500 miles from its proper position. And, just as in the past, areas of geographical ignorance were picturesquely camouflaged with drawings of dog-headed men, goat-horned and goat-footed men, headless men with eyes and mouths located in their chests, noseless men, men with ears of elephants, creatures which were half man and half woman, men with one eye, men with four eyes, men whose only protection from the intense tropical sun was a single tremendous foot which served as a sunshade, trunkless elephants (shown of all places on one map in Scandinavia!), dragons of the deep, gryphons, and sundry other equally fantastic biological monstrosities.

An abrupt end came to this type of cartography with the invention of triangulation survey methods. This event, more than any other, is responsible for the renascence of mapping. It marked the beginning of both modern cartography and modern geodesy for it systematized the small-scale map, introduced the fairly accurately surveyed large-scale map, and permitted more accurate determinations of the size of the earth.

The first modern triangulation net was laid out and surveyed in 1578–79 by Tycho Brahe. Centered on the island of Hven, it connected Denmark and Sweden across the Öresund.

The facts were buried amid the historical tomes of the Royal Danish Library. The few Danish cartographers who were familiar with Brahe's work for some reason or other—perhaps because of a false national modesty—refrained from seeking for it the international recognition it deserved. Consequently, credit for the introduction of triangulation is not generally accorded the proper person. Most cartographic historians were content to follow the lead of Clarke,[1] Eckert,[2] and the Jordan-Eggert[3] combination, who all unreservedly stated that Willebrord Snell of Holland executed the first modern triangulation in 1617.

There is no intent to minimize the genius of Snell. He is the father of modern geodesy, for he has the distinction of being the first to make a *scientific* measurement of the earth. Inspired by the work of the ancients, Eratosthenes and Posidonius, and critical of the methods used by the physician, Fernel, in




*Courtesy Danmarks Kortlaegning*

THE FIRST MODERN TRIANGULATION

measuring the earth in 1525, Snell conceived the idea of determining the length of the degree of the meridian by triangulation methods. It is not known whether he was aware of Brahe's triangulation techniques or if he conceived the idea on his own initiative. The figure he offered as the size of the earth was much too small.[4] But this is of little importance compared with his methods, which supplied a pattern of operations for the many measurers of the earth who followed.

The Danes must be a modest race. Though they have long been aware of Brahe's work in geodesy, they have never raised any objections to the fact that cartographers of other nations generally credit Snell with being the first to use triangulation. This same modesty is evident in *Danmarks Kortlaegning,*[5] the work of N. E. Norlund, to whom we are indebted for most of our facts concerning Brahe and his triangulation. Norlund says of Brahe's measurements that they "... form the oldest triangulation carried out in the Scandinavian countries ..." He modestly refrains from acclaiming Brahe's work as the first modern triangulation of any nation, though he very well could, and probably should, have done so.

The world is well aware of the accomplishments of Tycho Brahe in the fields of astronomy and mathematics. From his two famous observatories, Uraniborg and Stjerneborg, on Hven, he made the tedious but systematic observations of the heavenly bodies which fortified with fact the heliocentric theory of Copernicus. Without this groundwork, Kepler could not have completed the work of Copernicus. What is not generally known is that the genius of Brahe was not confined strictly to these two fields. The versatility of the man was astounding. He did much research in the study of weather, making daily meteorological observations on his island. Realizing the inadequacy of the astronomical and surveying instruments which were currently available in Europe, he designed and manufactured his own. Hven was a constant source of amazement and reflected its master's genius and independence. It had glass-blowing shops, chemical laboratories, a print shop, and a bookbindery. Brahe even installed his own paper mill which he powered with a system of more than 50 dammed ponds. And his library was the wonder of the time, attracting scholars from all Europe.

The triangulation of Brahe was a tight little affair. Its 21 stations, although confined to a geographical rectangle roughly less than 1° square, served to connect Copenhagen, through Hven, with the coast of what is now Sweden across the Öresund. A base line was measured on Hven between two of the four stations on that island. Numerous azimuth observations were made at Hven's Uraniborg Observatory. The remaining stations were about equally divided along the Danish and Swedish coasts. The network for which Brahe made two different sets of observations is illustrated in the accompanying figure.[6]

In 1937 the Danish Geodetic Institute carried out a detailed triangulation in Zeeland. In connection with this, the Swedish government permitted simultaneous angle measurements on Hven (now Swedish territory) to permit an evaluation of the accuracy of Brahe's original triangulation.[7]

Comparison with the modern triangulation reveals numerous errors in Brahe's triangulation. No doubt some of these result from the lack of proper length in the base line. Extending from St. Ibb's Church to the Uraniborg Observatory, it measured only 830 *passus,* or 1287.90 meters. The majority of the errors must, however, be attributed to the use of instruments which were not capable of the precise angular measurements of their modern counterparts.

The net result of comparison of Brahe's triangulation with the modern triangulation shows a constant error in both series of Brahe's observations. The average error of the first series is $-4'$; the average error of the second series is $\pm 13.1'$. But, when the constant error is subtracted, the first series is fairly inaccurate, while the second reveals a mean error of only $\pm 3.8'$.

A comparison of the angle measurements reveals an almost consistent positive error, very nearly proportional to the measured angle in each instance, with the mean average error being $\pm 17'$.

In the final analysis, the comparison is remarkable. Despite crude instruments, the mean errors of this first modern triangulation were amazingly low.

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2. Eckert, Max: *Die Kartenwissenschaft*, Berlin and Leipzig, 1921.
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5. Norlund, N. E.: *Danmarks Kortlaegning*, Vol. I, Copenhagen, 1942. This book is a work of art. In addition to presenting an excellent history of early Danish cartography, the volume contains an atlas devoted to remarkably clear reproductions of historieal maps of Denmark.
6. Norlund: *op. cit.*, devotes page after page to a faithful recording of the observations and measurements made by Brahe between the different stations. He displays his own thoroughness by having pursued a scholarly investigation to locate in terms of modern landmarks those stations which no longer exist.
7. Norlund: *op. cit.*, makes a detailed comparison of the modern observations with the old. Very skillfully, he eliminates apparent discrepancies by continuing his researches to locate obliterated and vaguely defined stations of Brahe. Space, unfortunately, does not permit the inclusion of Norlund's figures, studies, and conclusions for each point.

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## Precision Plotting Table

Rapid plotting and measuring of points on plane surfaces in terms of rectangular coordinates are simplified by this precision plotting table. Standard units have a 4- by 6-feet working surface and are based on decimal-inch measurements. Other table sizes, as well as metric division, can be supplied in special designs. The X and Y carriages are positioned to the nearest inch by notches spaced to an accuracy of better than 0.0002 inch. Even-inch notches are subdivided by means of short lead screws which provide only 1 inch of travel. Lead screws thus have a negligible accumulated error. Large-scale movements are made by disengaging latch. Intermediate adjustments to 0.001 inch are made by two hand cranks.—*Engineering News-Record*, June 29, 1950.

# The History of Land Surveying in Florida

*By* HERBERT D. MENDENHALL, C. E.

THE HISTORY of land surveying for Florida is as complex and ill-defined as it is for the remainder of the world, and so its recounting must touch only a few of the peaks that have emerged through the years.

It is impossible to assign the birth of surveying to any particular year, or even century. It is well established that it was used by the Chinese at an early date and by the Egyptians long before the Christian era to reestablish boundaries of tracts inundated by the annual overflow of the Nile. The earliest written survey records are those of the Romans, prepared in the alinement of their roads. It is probable that they made use of instruments not unlike the present-day planetable.

The first surveying activities in Florida evidently began soon after the landing of Juan Ponce de León on Easter Sunday, 1513, although a crude outline of the peninsula is shown on the Cantino Map of 1502. Ponce de León explored both coasts. Pánfilo de Narváez made similar explorations near Pensacola in 1528. In 1539–40 Fernando de Soto made extensive explorations, and in 1559 Tristan de Luna did the same near Pensacola. Pedro Menéndez de Avilés explored the coast from Cape Florida to St. Helena, after disposing of the Huguenots at Ft. Caroline, near the St. Johns River, in 1565.

The King George III Collection in the Library of Congress contains the de Brahm map of Florida, dated 1769. On this are shown a number of the old grants to private citizens.

All of these events, recorded in maps, evidence a substantial amount of actual land survey work, of a kind, done before the American Revolution.

After the separation of the Colonies from the Mother Country, the new Republic, now conscious of its independence, gave thought to its national geography and resources. It is recorded that on July 25, 1777, just 1 year after the Declaration of Independence, the Continental Congress passed a resolution authorizing General George Washington to appoint a "geographer and surveyor of the roads to take sketches of the country."

In May 1784, the Congress appointed a committee, with Thomas Jefferson as chairman, to prepare a plan for disposing of the lands of the public domain. This committee recommended that the territory be divided into "hundreds" of 10 miles square, each mile to contain 6086.4 feet. A revised report was submitted by William Grayson of Virginia on April 14, 1785, which changed the size of the "hundred" from 10 to 7 miles square and the name to "township" and substituted the statute mile for the "geographical" one. On May 20, 1785, after considerable debate, a final report was adopted changing the township from 7 to the present 6 miles square.

As might have been expected, a conflict of opinion arose between the New England and the Southern Colonies. The New England group favored a "definite and orderly survey, while the Southerners favored 'indiscriminate location,' in which the settler could take up a piece of land and have a metes and bounds survey made later." The Act, as finally passed, adopted the New Englanders' 6-mile-square township, but, as a concession to the Southerners, permitted the

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further subdivision of the township into sections, each 1 mile square (theoretically). This permitted the Southerners' "indiscriminate location" but tied it into the outer lines of the township.

Much discussion, wire pulling, and other political shenanigans, backed up by subtle, convincing, and sometimes biased, arguments, went on before the country became reconciled to the system adopted. However, by 1805 all differences seem to have been settled, and the rectangular system, practically as it exists today, became the one universally used.

The manner in which the boundaries of Florida were established is quite interesting.

On September 3, 1783, 1 year and 11 months after Cornwallis' surrender at Yorktown, a treaty of peace was concluded between the United States of America, represented by John Adams and Benjamin Franklin, and His Britannic Majesty, represented by David Hartley. Article II of this treaty contains a description of the territory being relinquished, part of which reads: "thence by a line drawn down the middle of the said river Mississippi until it shall intersect the northernmost part of the thirty-first degree of north latitude; thence due east in the latitude of 31° north of the equator to the middle of the river Apalachicola or Catahouche; thence along the middle thereof to its junction with the Flint River; thence straight to the head of the St. Marys River; thence down along the middle of St. Marys River to the Atlantic Ocean."

This line determined the north boundary of Florida.

On February 22, 1819, after considerable strife among the inhabitants, red, white, and black, and the invasion of Florida by United States forces, a "Treaty of Amity, Settlement, and Limits" was drawn up between the United States of America, represented by John Quincy Adams, and His Catholic Majesty, Ferdinand the Seventh, King of Spain. This treaty ceded to the United States "all territories situated to the eastward of the Mississippi, known by the name of East and West Florida."

However, previous to this, but subsequent to the Louisiana Purchase in 1803, the American Congress in 1812, on the theory that Spain already had ceded West Florida to France, annexed to Louisiana the area from the Pearl River to the Mississippi, and to the Mississippi Territory that from the Pearl to the Perdido River. This part of the negotiations remained intact, and so the Perdido River became the western boundary of Florida.

To activate the surveying of the public domain under the rectangular system, the office of Surveyor General was created on May 18, 1796. A Surveyor General of Florida, in the person of Col. Robert Butler, was authorized by Congress on May 8, 1822.

A later directive stipulated that: "Whenever the surveys and records of any surveying district are completed, the surveyor general shall be required to deliver over to the secretary of state of the respective states, or to such officer as may be authorized to receive them, all field notes, maps, records, and other papers appertaining to land titles within the same; and the office of surveyor general in every district shall thereafter cease."

Conforming to this directive, all such notes now are concentrated in the Field Notes Division of the Department of Agriculture, State Capitol, Tallahassee. Copies of them may be obtained from that office on request.

The office of Surveyor General of the United States was abolished by the Act of

March 3, 1925, 129 years after its creation, and its duties transferred to the Field Surveying Service, under the United States Supervisor of Surveys. The U. S. Land Office for Florida, in Gainesville, was abolished in January 1933.

Previous to the surveying of Florida under the rectangular system, many metes and bounds surveys defining boundaries of land grants to individuals were made. Characteristic grants were: One to Daniel O'Hara on Sept. 3, 1803, of 15,000 acres between the St. Marys and St. Johns Rivers; one to F. M. Arredondo on April 9, 1809, of 250,000 acres at "a place called Calasco Gachey"; and one to Peter Mirando on Nov. 19, 1810, of 368,640 acres on Tampa Bay.

Earliest rules for surveying were given to surveyors as manuscripts or printed circulars. Regulations in greater detail, improving the system for greater accuracy, permanence, and uniformity, were issued as Manuals of the General Land Office in 1855, 1881, 1890, 1894, 1902, and 1930.

The subdividing of Florida under the rectangular system began in 1824 with the establishment of the principal meridian in Tallahassee, by Benjamin Clements, followed by the survey of townships and sections in that area by Clements, R. D. Harris, J. and J. R. Donelson, Hays and Drake, and D. F. McNeil. The origin of surveys in Florida, located in Tallahassee, is described as in latitude 30° 28′ 00″ North; longitude 84° 16′ 42″ West.

Following the creation of the Everglades Drainage District in 1905, the subdivision of the unsurveyed portions of the Everglades south of Lake Okeechobee was accomplished under the direction of Fred C. Elliot, present Consulting Engineer for the Trustees of the Internal Improvement Fund. He found many inaccuracies, many almost ludicrous in extent, in the Township and Range Lines to which he had to connect his surveys. For example, he found that the south boundary of Township 41 on the east side of the Glades had "slipped down" 3 miles lower than the corresponding line on the west side. One of the control points was "Brown's store or Glades Cross Mission," an Indian trading post, located in Section 13, Township 48 South, Range 34 East. Mr. Elliot thinks that it may be the "lost town" recently "discovered" by hunters.

In considering these inaccuracies, it must be realized that many of the conditions surrounding the making of the early surveys militated against precision. Chief among them was the recompense to the deputy surveyors. It is recorded that, in one case: "as a full compensation for the whole expense of surveying and making plats, descriptions, and calculations, $3.00 per mile was paid, including the wages of chainmen and every other expense attending same." The more skillful deputies might be paid one-fourth to one-third more per mile. In some instances, however, the deputies received only $2.00 per mile.

This might account for some errors found in the original survey of Canaveral Harbor by W. S. Harris in 1859. It is estimated that in 3 days he ran about 25 miles, or an average of over 8 miles per day. His notes indicated that the vegetation was much the same as at present, and it is estimated that today a field party, doing the same work accurately, would take 8 weeks.

Another account of the hazards and probable cause of inaccuracy was the case of D. H. Burr, who surveyed in Duval County between 1840 and 1849. His work in the square sections was fairly accurate, but when he approached the St. Johns River he became confused. It is surmised that the live oak hammocks bordering the river were occupied by Indians—possibly hostile—or that a war canoe full of Indians was seen on the river; and so, rather than risk possible complications, he

completed his notes in the quiet and security of his camp. Actual surveys show his meanders to be at least ¼ mile in error. Burr later went West, where he laid out Salt Lake City, and at present there is a bronze plaque to his memory within 66 feet of a statue of Brigham Young in the Temple Square. Evidently desert surveying, minus Indians, was better suited to his style than were Florida hammocks!

So obvious were some of the errors that the surveyor general sent out inspectors to check up on some of the worst. One inspector's report, made in 1885, states that: "After many days of search, I was unable to find monuments for more than 5 miles, and the topography was wholly wrong for another 5 miles. Settlers said that the deputy who made the survey was accompanied by a saloonkeeper and stayed drunk. The original notes were stamped by a cheap rubber stamp with blanks in which numbers were inserted."

Still again: "Errors in alinement, mostly in the last ½ miles, indicated in each case a failure to survey the entire line."

However, these inaccuracies are the exceptions, and, as a whole, the surveys of the public lands under the rectangular system are surprisingly good, considering the conditions under which they were made. They have been of inestimable value to the public in describing tracts, not only in the original sale or grant by the Government, but in subsequent conveyances by and between private individuals. The reestablishing of these old land lines is a tedious and sometimes difficult job, requiring a considerable amount of technical ability and woodsmanship. Any present-day surveyor preparing to make such surveys should supply himself with full instructions as found in the "Manual of Instructions for the Survey of Public Lands," by the General Land Office, and "A Treatise on the Law of Surveying and Boundaries" by Frank E. Clark.

The rectangular system, while meeting the requirements for the practical description and disposal of land, does not provide an accurate means of tying together the land areas on a nation-wide basis. For this reason the Federal government has assumed the responsibility for establishing a triangulation net covering the whole country, and the Coast and Geodetic Survey (USC&GS) was assigned this task.

In 1845 the Coast Survey started a triangulation net in Florida which has been progressively carried on to completion. But this net did not tie into the rectangular system except through the geographical description of the guide parallels and meridians and through the triangulation stations. As a step toward remedying this, the Florida Engineering Society, in 1920, petitioned the USC&GS to establish a meridian line in each county seat in the state. This was accomplished in 1922–23. Copies of manuals on the subject can be obtained from the Superintendent of Documents in Washington, D. C., under the title "Magnetic Declination in Florida."

As a further effort to tie the local systems into the national net, the USC&GS in 1933 developed the State Systems of Plane Coordinates. A discussion of these Systems is contained in the following USC&GS Special Publications: No. 194, entitled "Manual of Traverse Computation on the Lambert Grid"; No. 195, entitled "Manual of Traverse Computation on the Transverse Mercator Grid"; and No. 235, entitled "The State Coordinate Systems." The latter publication is a Manual for Surveyors and explains the practical application of the Coordinate Systems to surveying problems. All of these can be obtained from the Superintendent of Documents.

Still further in the same direction, the American Society of Civil Engineers published Manual No. 20, entitled "Horizontal Control Surveys," which provides methods for coordinating all of the various surveying systems.

In 1939 the Florida Engineering Society presented to the State Legislature a bill to establish a Plane Coordinate System for Florida. To date it has not been passed, but, conscious of the great need, the USC&GS has actually set up in Florida a Plane Coordinate System, which is being used by the State Road Department, the U. S. Engineers, other governmental departments, and many large private organizations. Under it, there are set up East and West Zones, based on the Mercator projection, which is especially adapted to areas with the long dimensions north and south, and the Northern Zone, using the Lambert Conformal Grid, which lends itself best to areas with maximum dimensions running east and west. The boundaries of these zones can be found in many publications.

In 1934–40 a Florida mapping project ran approximately 3,900 miles of second- and third-order traverses, in which about 3,500 concrete monuments were set, covering some 7,000 square miles. But no provision was made for safeguarding the monuments, and at the present time it is estimated that more than one-third of them have been destroyed. To cover the state completely would require about 27,500 horizontal control points, or one every 2 miles.

The land boom in Florida during the twenties created a great need for surveying, and, in accordance with the saying "where the carcass is, there the vultures do congregate," a swarm of self-designated "surveyors" quickly sprang up. A large proportion of these "vultures" were wholly incompetent to make a correct survey or a map to represent it; but just the same, they butchered the terrain into innumerable subdivisions and plastered the landscape with maps and plats completely devoid of data that would enable a future owner to reestablish his boundaries.

Realizing the seriousness of the situation, the Florida Engineering Society, backed by the professional engineers of the state, was influential in having the Plat Filing Law enacted in 1925. This required that certain data be shown and sworn to on a plat before it was accepted for filing. It was the duty of the county clerks to check the plats or have them checked by a competent surveyor before filing them. This law has been only partially enforced.

Moreover, it only partly met the abuses. The original Professional Engineers Law, passed in 1917 and amended in 1925, permitted any registered professional engineer to do land surveying. It is regrettable that many such, while possibly good engineers, were wholly unqualified to do land surveying and committed as many depredations on the land as did the unregistered charlatans. To remedy this defect, the Florida Engineering Society, in 1931, sponsored the passage of a Land Surveyors Law, which set up standards of qualifications for land surveyors. Although there still are a few incompetent men defying the law and continuing to practice, the situation has cleared up to a great extent.

A development of the subject of surveying would be incomplete were the mention of aerial surveying omitted. Following World War I, this method gained great impetus. Many counties of Florida have had complete surveys made, and the State Road Department uses them consistently in projecting new roads and correcting the alinements of old ones. Various governmental agencies, such as the Navy and the U. S. Engineers, use aerial surveys extensively, and the USC&GS recently has made a complete survey from Ormond to Key Largo, and

from Cape Sable to the Caloosahatchee River. Where such surveys have been made, the maps are available at a moderate price by application to the governmental or state agency that made them.

In conclusion, it is pertinent to mention some of the outstanding projects involving land surveying that have been done by other than governmental agencies. On January 6, 1855, the Florida Legislature passed an Act creating "The Trustees of the Internal Improvement Fund." These trustees, generally designated as "The I. I. Board," administer all matters relating to public lands within the State and particularly all swamp and overflowed lands that might be reclaimed, or otherwise have a value. At times since its creation, the Board has had tremendous problems to solve, the largest of which was the Everglades Drainage Project. This project, authorized in 1905, has had as its engineer since its inception, Mr. Fred C. Elliot.

Another project, also a responsibility of the I. I. Board and well known half a century ago, was the Disston Drainage Project. This was the outgrowth of the embarrassment of the I. I. Board in regard to bonds involved in grants to railroads during the early development of the State. To raise funds, the Board, on February 26, 1881, sold to Hamilton Disston and Associates of Philadelphia several million acres of swamp and overflowed land at 25¢ per acre, on condition that such lands, and others adjacent to them, would be drained and rendered cultivatable. Certain areas were satisfactorily drained around Lake Tohopekaliga, near Kissimmee, and some canals dug adjacent to Lake Okeechobee, but the contract was never completed and was terminated on December 31, 1893.

Another large project involving surveying of an involved type was the Florida East Coast Railroad Extension over the Florida Keys to Key West. This was initiated about the turn of the century, and built under the direction of Mr. E. Ben Carter, Chief Engineer, of St. Augustine.

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## Rime of The Ancient Cartographer

*Each day I sit with pen in hand,*
*With compass, ink, and blotting sand,*
*With straight-edge ruler and divider,*
*Triangle, T-square, and protractor.*

*I draw and dream, and dream and draw*
*The shores and hills of Panama;*
*The coasts of Malabar and Goa,*
*Cipango, Thai, or New Angola.*

*I draw not what mine eyes hath seen,*
*Nor prompted by an inner dream.*
*I put down what Balboa saw;*
*Alas for me! I only draw.*

*The geographer needs must travel ever.*
*The cartographer never.*

—Lyman D. Lynn

# Permanence of Certain Coloring Materials

*By* HAROLD F. WILLIAMS
DRAFTSMAN, STATE OF WISCONSIN

THE ACCOMPANYING TABLE portrays the results of a study in color permanence. Sources of the 99 colors used were 78 colored or black lead pencils, 7 colored inks, 6 colored "grease" pencils and 8 colors of transparent cellulose sheeting. All of these were in a drafting room for use in preparation of display maps and charts and for keeping records of various kinds and were not otherwise selected for the test.

Two sheets of a good quality artists' board were laid off in half-inch squares, and one square on each sheet was uniformly filled with each color. On March 11, 1949, one of the sheets was placed in an east-facing window, colors outward, of a well-ventilated office, and the other sheet was placed in a folder under a desk blotter.

Nearly 8 months later, the colors on the two sheets were compared. The colors on the sheet which had been in the dark were also compared with colors freshly applied and were found to have suffered practically no alteration. Approximately one out of every two applications on the sheet which had been exposed to the light had become unrecognizable as the color applied.

## EFFECTS ON SPECIFIC COLORS

Disregarding the blacks and browns, which were mostly unaltered, the results for the other colors may be summarized roughly by saying that three out of every four colors had either vanished completely or were unrecognizable as the colors applied 8 months previously. No material difference was noted in the behavior of the different classes of materials.

A glance at table 1 shows the least change for *blacks*. The only one that exhibited a slight fading was a special pencil for use on a special medium.

Of the three *whites*, one showed a slight change by becoming whiter. This was the only intensification of the original "color" noted after 8 months.

The *reds* were the most impermanent. The one red recognizable as the color applied showed only slight fading and slight color change and this was decidedly on the orange side, not ordinarily considered a red.

The artists' board itself showed no yellowing or other appreciable color change from the original white.

## CONCLUSIONS

Enough observations were made at intervals in the 8-month period to establish the fact that some colors faded much faster than others. At the end of 1 month at least six of the colors had faded completely and, of these, one or two had vanished at the end of a few days. It was also noticed that of the colors which faded completely several underwent some color alteration before vanishing. It is likely that if the test were to continue beyond the 8 months further color alterations would occur.

Although no specific tests were made in the absence of direct sunlight, it was noted from maps on walls of the drafting office, to which these same colors had been applied, that fading and color alteration seem to occur for the most part in

some proportion to the amount of sunlight falling directly on the color. That is, fading and color alteration occur whether sunlight hits the color but at a slower rate in daylight which does not include direct sunlight.

These observations with respect to the deleterious effects of daylight on some colors do not preclude the possibility of color alteration in the presence or absence of light due to some quality of the coloring matter itself, due to the reaction between the color and the surface to which it is applied or between the color and some component of the atmosphere, or due to any combination of these and other factors.

The conclusion as to the use of colored pencils of various kinds, colored inks, and other colored overlay or coloring materials of the types used in this test, in the graphic arts, is obviously that if the colored subject is to be exposed to daylight for any length of time, and if it is desired that the colors be permanent, a test of the permanence of the particular colors under the conditions in which they are to be used is very necessary.

The National Bureau of Standards of the U. S. Department of Commerce, in a letter dated November 23, 1948, advises that for artists' oil paints there is a recorded voluntary standard of the trade covering permanent paints and that the Federal Government requires certain standards of permanence for the writing inks it uses. For the numerous other coloring materials widely used in the graphic arts no generally accepted standards of permanence appear to exist, and there is no legislation requiring manufacturers of coloring materials (pigments, paint, inks, pencils, crayons) to label products as to their permanence.

TABLE 1.—*Test of permanence results of an 8-month exposure to daylight of colored pencils, inks, and cellulose sheeting*

| Color | Number of colors | Unrecognizable as the color applied | | Recognizable as the color applied | | |
|---|---|---|---|---|---|---|
| | | Complete or nearly complete loss of all color | Pronounced fading and/or pronounced color change | Slight color change and usually slight fading | Slight fading, same color | Little or no fading or color change |
| Blacks | 15 | 0% (0) | 0% (0) | 0% (0) | 7% (1) | 93% (14) |
| Browns | 10 | 20% (2) | 0% (0) | 0% (0) | 0% (0) | 80% (8) |
| Whites | 3 | 0% (0) | 0% (0) | 33% (1) | 0% (0) | 67% (2) |
| Orange | 6 | 33% (2) | 50% (3) | 0% (0) | 17% (1) | 0% (0) |
| Yellows | 5 | 20% (1) | 0% (0) | 0% (0) | 60% (3) | 20% (1) |
| Blues | 16 | 56% (9) | 19% (3) | 0% (0) | 6% (1) | 19% (3) |
| Greens | 19 | 32% (6) | 26% (5) | 11% (2) | 5% (1) | 26% (5) |
| Reds | 25 | 76% (19) | 20% (5) | 4% (1) | 0% (0) | 0% (0) |
| Total | 99 | 39% (39) | 16% (16) | 4% (4) | 7% (7) | 33% (33) |
| Recognizability | | 56% (55) | | 44% (44) | | |

# Is Today's Surveyor Archaic?

*By* THOMAS E. RILEY
REGISTERED OREGON SURVEYOR

WE SURVEYORS present a bizarre facet in the midst of modern civilization. Surrounded by efficient machines and marvelous engineering projects, we still perform our part with the routine methods we learned 50 to 75 years ago. Perhaps our surface appearance has changed—today the multi-pocketed cruiser's jacket is in vogue and the laced boots are out—but our surveying is the same.

Are we archaic?

Manufacturers of surveying instruments say so. In an article published in the October–December 1948 issue of SURVEYING AND MAPPING, I criticized U. S. makers for their failure to incorporate any of the advancements of the European surveying instruments into their own. They write me that it has so far been impossible to use any of these improvements—even the most elementary—for the simple reason that the man in the field will not accept any surveying instrument he has not already used.

Contractors say we are archaic. There is nothing more irritating to a contractor than seeing his modern, earth-moving equipment held up by the lack of a few bluetops or control points. And contractors say that preliminary surveys are becoming more bother than use, that the surveyor is too slow for the rush of bidding on a job when fast estimates of areas and quantities must be figured. In other words, contractors believe that construction has far outsped its surveying.

Lawyers also say we are behind the times. They state that even cadastral surveyors, though in a profession that deals constantly with legal aspects, do not know the complexities of property laws, do not today even know where to find the legal data. And the lawyers may have something there. Most of us like to consider ourselves virile outdoorsmen; as a result we are better suited to chasing bears off an unknown mountaintop than proving a point for the courtroom. The trouble is that there are few unknown mountaintops left lying around—the frontier is vanishing.

Personally, I believe we must agree, at least in part, with each of these critics, and I am a surveyor. If a survey crew of 50 years ago should step out of the shadows today, those men could do just as good a job as I can do now. And they would do it the same way. This does not denote progress. We cannot even point in defense to other professions and say, "Look, they're as bad as we are!" No other professional group has shown the lack of interest in improving its tools and methods that we have evidenced.

Of course, there is another side to this question. We often grumble that when a doctor makes a mistake he buries it, but when a surveyor makes a mistake he builds a monument to it. And John C. Trautwine, in the preface to his well-known *Civil Engineer's Pocketbook*, brought out a point when he said: "Comparatively few engineers are good mathematicians; and, in the writer's opinion, it is fortunate that such is the case; for nature rarely combines high mathematical talent with that practical tact and observation of outward things so essential to a successful engineer."

Trautwine's statement boils down to the point that an engineer must be a

practical man with common sense. And such is especially true of the surveyor in the field. Almost half of his work is a procedure to prevent mistakes. It has to be, and he cannot afford to be hampered with super-complex instruments that belong in a laboratory nor with complicated methods of procedure which would mean still more time spent in preventing errors. He needs as simplified a surveying procedure as possible so that his time can be spent on the immediate problems of the weather, the terrain, and the job.

## RESISTANCE TO CHANGE

But is this any excuse for being archaic? Probably most of our reluctance to try anything new stems from this need for simplification. But what we have done is lean too far backward and exclude the very things that could simplify and improve our work. We suffer from a hardening of the attitude.

An example of this is the subtense bar. Fully accepted in Europe, its possibilities have hardly been touched in the United States. If you were to offer it to most surveyors here, they would say "no thanks, too complicated." Actually, the subtense bar traverse has been ignored because it is different, not because it is complicated. The transitman simply reads the angle between the two targets on an invar bar which is an unknown distance away. He then knows the exact distance (from a simple table carried in his pocket) and also the azimuth—all in one operation. He can measure across a canyon or swamp as quickly as across a ball park; and, even more important, he has absolutely no correction to make when measuring up or down a slope. The method requires a smaller crew with only one skilled man, is next in accuracy to the invar-taped baseline, and is much less subject to mistakes than any chained line. It also gives something new in traversing, a way for either the office force or the field crew to prove a line after each day's work, whereas the results of a chained traverse are unknown until the whole line is completed. But we don't even try it.

A more common example of our leaning backward is in the tremendously long telescopes that we demand on our instruments. Recently, an instrument manufacturer told me that one U. S. firm 20 years ago, anxious to improve its transits, incorporated the compact telescope used in Switzerland's Wild instruments. No one would buy it. The telescope was lengthened "to give it more accuracy," and then we accepted it. Now, if this telescope had been just a piece of gas pipe, doubling its length would have increased its accuracy; but, as the maker admits, lengthening the optical system gave it no advantage. The transit, instead, was larger, heavier, and more greatly affected by the wind; the telescope had less resolving power. And we still like this instrument!

Today another manufacturer reports that his bulky 18-inch dumpy levels were rejected on a Government bid because they were too short. Too short! The 18-inch dumpy is longer than our precise levels and three times as long as equivalent Wild levels today. Perhaps Mr. J. L. Rannie of the Geodetic Survey of Canada was right when he said we seem to buy our levels by the yard.

We field men look even more archaic when we realize that our survey office forces have been quick to take advantage of any improvements offered to them. For instance, the electrical survey-net adjuster of the U. S. Geological Survey has received immediate and widespread interest. And already the new International Business Machines electric surveying calculator has every office force excited—and it isn't even on the market as yet. But we field men have been against any change, even when something has been proved for years.

The top men of Government survey agencies, the men you might call the leaders in surveying, are today heralding the "new" theodolites, the Swiss optical theodolites. This is no credit to our profession, no alert grasping of an advancement, for these men and the rest of us have refused to accept the same optical instruments for 25 years. We are simply 25 years behind in accepting a definite improvement in our tools.

In a nutshell, we refused to believe that a geodetic instrument could be compact and still be easy to read. The optical theodolites were invented 30 years ago. They were immediately accepted in Europe for what they were, a major advancement, and have been used there almost exclusively for 25 years. Canada and South America discarded our bulky, clumsy theodolites years ago in favor of the optical instruments, and the U. S. Army about 1939 found that the efficient Wilds were the only instruments accurate enough, fast enough, and weatherproof enough for wartime control surveys. We admit their worth only today.

And we still ignore the fact that there is an optical transit, an instrument that brings all the efficiency and speed of the optical geodetic theodolites into the field of the ordinary surveyor. In Europe the directional type of transit or theodolite is also used for ordinary surveys. But here in the United States we prefer a repetition type of transit and therefore do not use such directional theodolites for construction or cadastral work. But the Wild T1, an optical repetition transit, has been available for several years, built specifically to replace our ordinary transits. It gives the efficient optical reading, the light weight and compactness, the optical plumb bob—all the improvements of the optical theodolites—without requiring any change in our system of surveying. Also there are new optical levels, compact, weatherproof, and with an advanced method of leveling the bubble. These are fairly new instruments—will we wait 25 years before accepting them?

Even the U. S. Army is less brass bound than we civilian surveyors. The Army has been making interesting experiments as to the efficiency and weatherability of surveying instruments. The researchers found that it is impossible to completely enclose an old-style transit or even to make it dust and rain proof because of the way it is constructed. They recommended optical transits. The researchers found that the tapered bronze bearings in the ordinary transit are greatly affected by changes in temperature and recommended the optical transit's ball bearings and cylindrical axis. On every point they found the optical instruments superior and are now demanding them in bids for both construction and control work. U. S. makers, anxious to receive the revised Government bids, are today designing instruments similar to the Wilds. They admit they are woefully behind on manufacturing know-how and state it will be several years before any production will begin. They blame the field surveyor because he has shown no interest in these instruments in the past. Perhaps they are right.

Some people blame our educational system for our archaism. Colleges have always considered surveying a shirt-tail cousin to civil engineering. It is squeezed and jammed into short "vernier-reading" courses with no attempt to teach the intricacies demanded of modern surveying. A man who wishes to be a surveyor must take most of his lessons from the slow school of experience. Educators do admit that they are behind in the needs of our profession, but few of them consider it important enough to improve their courses. Few colleges have ever seen an optical transit.

### GOBBLEDYGOOK IN PROPERTY SURVEYS

But no college can be blamed for the "gobbledygook" phraseology that we ourselves use in describing a piece of property. In cadastral surveys we seem to like such descriptions as: "Beginning at a point in the thread of the channel of Mud Creek from which an iron pipe beside a pine tree 12 inches in diameter bears South 37° 54′ West a distance of 24.4 feet and running by fence and land North 83° 21′ West a distance of 832 feet to an iron pipe bearing . . . thence turning . . . following . . . bearing . . . turning. . . ." Often we run such a metes-and-bounds description a full page or two, all of it one sentence, all of it a confusing jumble of phrases and clauses. This is a minor archaism from our own personal viewpoint, for we learn in time to understand it; and part of the blame here lies with lawyers who demand legal terminology. But at least we could use shorter, simpler sentences so that the public could possibly understand them. And is there really any honest reason for all the "gobbledygook?" This isn't the day of the medieval guilds when the skills of a trade were a carefully guarded secret. We are working for the public and we should be able to put down property descriptions in a form that the average person can understand.

### AVAILABILITY OF DATA

Another seeming medieval secret is in the coordinates and elevations of control monuments. These little bronze disks are scattered around the countryside by city, state, and federal surveyors for other surveyors to tie their work into. Each governmental agency is the only one that has records on its own control monuments—there is no over-all consolidation available so that a surveyor can know the existence and location of all monuments in an area. These control data could be of real value if they were easily obtainable.

### WE NEED A CODE OF ETHICS

We show we are archaic in the matter of charging for private surveying jobs. Surveyors have no code of ethics as do architects, doctors, and other professional men. When a property owner can ask for bids on a survey of his land and then receive estimates that vary from $50 to $500, it is obvious something is wrong.

We cannot blame the general public if such things lower our profession in their eyes. And such a condition has definitely arrived. In April 1948, the National Labor Relations Board ruled that surveyors were not professional people and therefore could be unionized into any labor union without the special professional provisions—in other words, we are common tradesmen. Yet it has been held in civil court decisions that a surveyor is a member of a learned profession and may be held liable for incompetent services rendered. We are liable for all damages resulting from an erroneous survey, may not plead that the survey was not guaranteed, and are liable in any case where we do not exhibit a reasonable degree of prudence, judgment, and skill. It seems we have fallen into a peculiar classification. We can be sued as if we were doctors; we are paid as tradesmen.

### MODERN SURVEYS REQUIRE SPECIALIZATION

There is another matter about which most of us try to remain static, do not want to change. This is specialization. Psychologists would probably say this is archaism, the result of a desire to remain as the rough-and-tough gentry who

can just grab a transit and stake out the world. That isn't done today. The high value of land, the demand for better maps, the complexities of construction —today's intricacies of civilization—demand specialists in surveying as well as in medicine and law.

In spite of ourselves we are becoming specialized to some degree. The surveyor who runs control for the Multiplex and Stereo-Autograph is specialized in picking out control points identifiable from the air, judging the average height of the trees in the forests, and running a form of reconnaissance as he surveys. His surveys must be a modern combination of triangulation and traverse to give second-order accuracy with the rapidity and economy that is needed in such work. He must be a specialist.

The construction surveyor today must know the problems of modern building construction, of highways, and of airport construction. The cadastral surveyor now spends his time either subdividing or relocating old surveys—a job that can be extremely complicated. The days are gone when any of us could one week measure townships with a handkerchief tied to a wagon wheel and the next week lay out a transcontinental railroad with a compass. But most of us do not seem to like it.

We need to accept specialization. We need to be professional, to grasp new tools as soon as they are proved and try new methods whenever they show promise. If we do not, we should all admit we are archaic.

## Aqua Locator

A NEW TYPE of dip-needle locator, called the Aqua Locator, has been marketed by the Aqua Survey and Instrument Company of Cincinnati. Features of the instrument are its compactness; an exclusive periscope type of mirror arrangement, which enables it to be read from the top as well as from the side; a chrome nickel handle for setting it in difficult locations; and a 35-percent cobalt alloy steel needle for which long-life magnetization is claimed. The needle may be adjusted and balanced at the company's plant to conform to magnetic conditions in any part of the world. The instrument may also be used as a compass.

The instrument is provided with a leather case and long shoulder strap facilitating exploration in awkward terrain and reading of the dial without stooping. Surveyors or engineers confronted with the task of locating lost valve boxes or pipes should find the device exceedingly useful.

## Forty-fourth Annual Meeting of Canadian Institute of Surveying and Photogrammetry

The Canadian Institute of Surveying and Photogrammetry takes pleasure in announcing that it will hold its Forty-fourth Annual Meeting at the Chateau Laurier, in Ottawa, Canada, on the 7th and 8th of February 1951.

A most cordial welcome is extended to members of the American Congress on Surveying and Mapping and their friends to attend and take part in the proceedings.

If those members planning to attend will advise the Program Committee Chairman, John Carroll, at the Institute's address, 41 Grove Ave., Ottawa, Canada, the necessary hotel reservations will be gladly made.

# The Need for College Training in Geodetic Surveying

*By* SERGE A. EMERY, C.E.

THE HISTORY of the United States is one of increasing land values and a corresponding demand for more accurate methods of land measurement. Therefore, the need for geodetic engineering—that branch of surveying which deals with the exact location of points, and the accurate measurements of large areas, on the earth's surface—is certain to increase in the years ahead. Population increases alone will bring this about.

Consider the fact that the population of this country (131 million in 1940 and 150 million this year) will be approximately 225 million in the year 2000 A.D., if the present rate of increase continues. This population growth of 50 percent in the next 50 years will certainly result in the enlargement of our present centers of population and in the layout and development of new towns and cities. All this points to the need for a new type of professional engineer not now being trained by our colleges and universities—the geodetic engineer.

For a century certain European engineering schools have given special instruction in geodetic surveying. There is not a single surveying or geodetic engineering department included in this country's colleges or universities. In 1947, 160 colleges and universities offered courses in engineering.[1] An interesting fact in this connection is that, possibly because of higher land values in the United States, distances in urban areas here are usually measured to 0.01 foot of accuracy. In the majority of European countries, the field measurements in the large cities are considered acceptable to 0.01 meter. In Europe the demand for geodetic engineers is very great because the civil engineer rarely, if ever, receives adequate training in geodetic engineering.

The average civil engineering college here or abroad gives instruction in the elements of land surveying, to be sure. However, competition for the students' time is very keen. Such subjects as railroad and highway construction, bridge engineering, hydraulic engineering, and many others are included in the curriculum. Adequate instruction in so exact a science as geodesy is therefore almost impossible in the usual civil engineering department.

It appears to the writer that the time has arrived for the establishment in the colleges of the United States of courses leading to a professional degree in geodetic engineering. A professional engineer, to be equipped to solve geodetic problems on any scale, would require instruction in the following as well as other subjects:

| | |
|---|---|
| Applied mathematics for geodesy | Geology |
| Geodetic surveying | Astronomy |
| Geodetic instruments and computations | City planning |
| Land surveying | Land evaluation |
| Photogrammetry and aerial surveying | Sanitation and drainage |
| Cartography | Real estate law |
| Cadastral surveying | History of Geodesy |

Languages (at least one in addition to English)

[1] BRUMBAUGH, A. J.: American Universities and Colleges, *American Council on Education*, 1948, Washington, D. C., p. 81.

Many of the above subjects would require not only lectures but also laboratory, drafting room, and practical field instruction and experience. A well-organized 4-year course in geodetic surveying might well lead to the degree of Bachelor of Science in geodetic surveying and to a master's degree after an additional year of instruction. The well-trained geodetic engineer would be able not only to meet present needs for geodetic surveying, mapping, and city planning but also to anticipate future public and private needs in this field.

The writer believes that there will be a constant and increasing demand for the services of geodetic engineers in federal organizations such as the U. S. Coast and Geodetic Survey, in state planning commissions, highway departments, and county assessors' offices, and in private land surveying organizations.

It is hoped that this brief article may influence education in the field of civil engineering toward inclusion of more thorough instruction in geodesy which would lead to professional degrees in geodetic engineering.

## Gulf Stream Meanders

THE GULF STREAM does not stay put. It meanders far from its supposed course, sometimes doubling back on itself, sometimes looping so that it creates vast eddies which break off from the stream.

Rear Admiral Edward H. Smith, who recently retired after 40 years of service with the Coast Guard and became director of the Woods Hole Oceanographic Institution, said that this view of the action of the Gulf Stream was confirmed by a recent six-vessel survey of the current. He spoke over the Columbia network as guest of Watson Davis, director of Science Service.

Admiral Smith said that the new knowledge of the Gulf Stream was due in great part to the use of Loran—a war-developed radio system of navigation—which permits survey ships to fix their positions as often as they wish. Before Loran was introduced it was possible to achieve accurate fixes only twice a day, he said, and thus the net effect of a current over only a half day was known.

"Probably the Gulf Stream is an extreme case," Admiral Smith said. "When other currents are studied as intensively as the Gulf Stream, they may be found to be somewhat steadier. However, it is already clear that the variability of the ocean circulation is much greater than was anticipated."

Right now, Admiral Smith said, oceanographers are studying the how and why of currents. After that picture is clear, the job will be to find out how currents affect the weather. He pointed out, however, that the Gulf Stream would have an effect on the weather in Europe, not in the United States.

"Ocean circulation is much like air circulation," Admiral Smith said, "but it is much slower. A week in the ocean is apparently equivalent to a day in the air, so far as circulation is concerned."

The new director of the Woods Hole Institution said that oceanography is just about entering the phase where it can begin to forecast ocean circulation. With new investigational techniques and instruments, he concluded, oceanographers will be able to describe the movements of the ocean accurately and will be able to understand just what sort of an ocean we are dealing with.—*Science News Letter*, July 8, 1950.

# History and Present Status of Geodetic Control in Southern California

*By* LT. COMDR. DANIEL WHELAN, JR.
U. S. COAST AND GEODETIC SURVEY

I AM HAPPY to take part in this inaugural program of the Los Angeles Section of the American Congress on Surveying and Mapping. The objective of the society—to advance the art and science of surveying and mapping—probably will be most effectively served by local section activity such as we begin tonight. It seems quite appropriate that the integrated program of papers, which have been planned for this and future meetings, should begin with a consideration of the history and background of geodetic control, since, in the very nature of proper procedure, the control surveys should ordinarily come first.

As time is limited, my remarks will be confined principally to matters pertaining to horizontal control; that is, astronomic determination of geographic position and first-order triangulation. Vertical control, the establishment of tidal datum planes, and the discussion of the various adjustments which have tied the level nets to a common datum, could well be made the subject of another paper. At this time it will suffice to say that from 1878 on, the network of precise geodetic leveling has been systematically extended. The expanding nets of level lines, the use of more precise instruments and other equipment, and the accumulation of continuous records at principal tidal stations have necessitated readjustments from time to time. The 1929 special adjustment includes the Canadian first-order nets and holds sea-level datum fixed at 26 principal tidal stations. This adjustment furnishes a datum for vertical control for the United States and Canada, which should remain fixed.

Let us then return to the subject of horizontal control and trace the history of the work which has, in a sense, put southern California on the map and in its correct position.

If we were to record merely statistics of the work, it could be discussed and could be shown quickly by a series of progress sketches. Such an approach would likely prove to be a dull presentation. In order to make a liberal interpretation of the assigned subject, this talk will include something of theory, something of history, something of methods, and something of the men who contributed to its development.

## EARLY GEODETIC WORK

As one investigates the history of geodetic control in the United States, he is quickly impressed with the fact that even the earliest work compares favorably in accuracy with some of the current work. Since 1807, when President Jefferson received authority from Congress to cause a survey to be made of the coast, the primary or first-order geodetic control has been executed to a high degree of accuracy. Hassler recognized the fundamental necessity of precise geodetic control in order to place properly the extensive territory of the United States on

Paper read at meeting, Los Angeles Section, American Congress on Surveying and Mapping, June 24, 1949.

the true figure of the earth. He recognized, also, that the lengths of the triangulation arcs must be utilized eventually to redetermine the figure of the earth, and to provide the basis for a more precise adjustment of geographic positions on the sea-level figure of the earth—when more exact knowledge of the size and shape of the earth was available. It is to his honor and to the credit of the men he inspired that much of this earliest geodetic work is still usable in our modern surveys and meets the high standards of accuracy demanded of present-day geodetic control.

The outstanding advances over the years did not come in greatly increased accuracy, but the necessary accuracy was obtained more rapidly and more economically. Improvements in instruments, in transportation, and in communication contributed to these advances. Perhaps better trained men also were responsible in part for some of our advances; but, as we consider the accomplishments of men like William P. McArthur, George Davidson, A. T. Mossman, and others who worked on the early surveys of California, we must conclude that these pioneers of surveying and mapping in California measured up to the highest professional standards.

## GOLD RUSH ACTIVITY

It was just 100 years ago, along with the gold rush, that precise surveying came to California. Any judgment of the seemingly slow progress of geodetic control in this area must be made with a knowledge of the peculiar circumstances and conditions which prevailed at that time. The wave of gold seekers and adventurers which poured into California from 1849 onward created a state of emergency conditions, which required that the first work of the Coast Survey was to provide for the safety of navigation, as far as funds allowed, by means of coast and harbor surveys, mapping of rocks, shoals, reefs, and other dangers to navigation, and prompt publication of such information in the form of charts. Much of this work had to be done hurriedly and was consequently largely of a temporary character. Astronomic expeditions were organized, and the positions of many prominent points were determined from 1850 to 1853. In addition, several local triangulation nets were surveyed. Latitudes were determined by means of zenith telescopes, and longitudes by means of transits and chronometers. The various expeditions to the northward and southward of San Francisco were ultimately connected with that city as the central station. The longitudes of a number of stations were determined from observations of moon culminations, collected and referred to San Francisco in order to establish a common geodetic datum to be used for all surveys in California.

To say that these surveys were made under difficulties is to understate. The expeditions were beset with shipwreck, mutiny, desertion, and disease. To illustrate, in 1849, William P. McArthur reported mutiny on the Coast Survey schooner *Ewing* in San Francisco Bay. A boat's crew seized Midshipman Bigson, the officer-in-charge, threw him overboard, shoved him underwater with an oar, and left him to drown while they deserted to dig gold. Bigson managed to reach shore alive. McArthur immediately took steps to apprehend the deserters. They were captured, tried by court martial, and two of them executed by hanging, one at the yardarm of the *Ewing* and the other one on the battleship *Savannah*. McArthur's words in reporting the execution were: "Thus have I passed through an ordeal as repugnant as it was necessary." Also: "The

Theodolite—1889–90.

Astronomical transit—1893.

Triangulation station ROUND TOP, California 1876.

effect which this solemn affair has had, so far as can be perceived, is highly beneficial and I feel convinced I shall have no more trouble." Whether he had further trouble or not, he vigorously pressed forward with his program, and a usable chart of the coast from San Francisco to the Columbia River resulted from his work that year. Just a year later, while on his way home, McArthur died in Panama of dysentery which he had contracted in California.

In 1851, another Coast Survey steamer, the *Jefferson*, foundered in a storm off Montevideo while on her way to California. The entire crew were saved, but later one man died from exposure.

I cite these events as examples to emphasize the practical difficulties under which early surveys were prosecuted. And yet, good work was done. That the ultimate objective was kept clearly in mind is evidenced by the excellent reconnaissance surveys accomplished, by the strength of the control figures selected, and particularly, by the careful and complete observations made when time permitted. The immediate needs, too, were given proper attention, and charts and maps of the territory were rapidly published to give the best available aids to navigation and commerce.

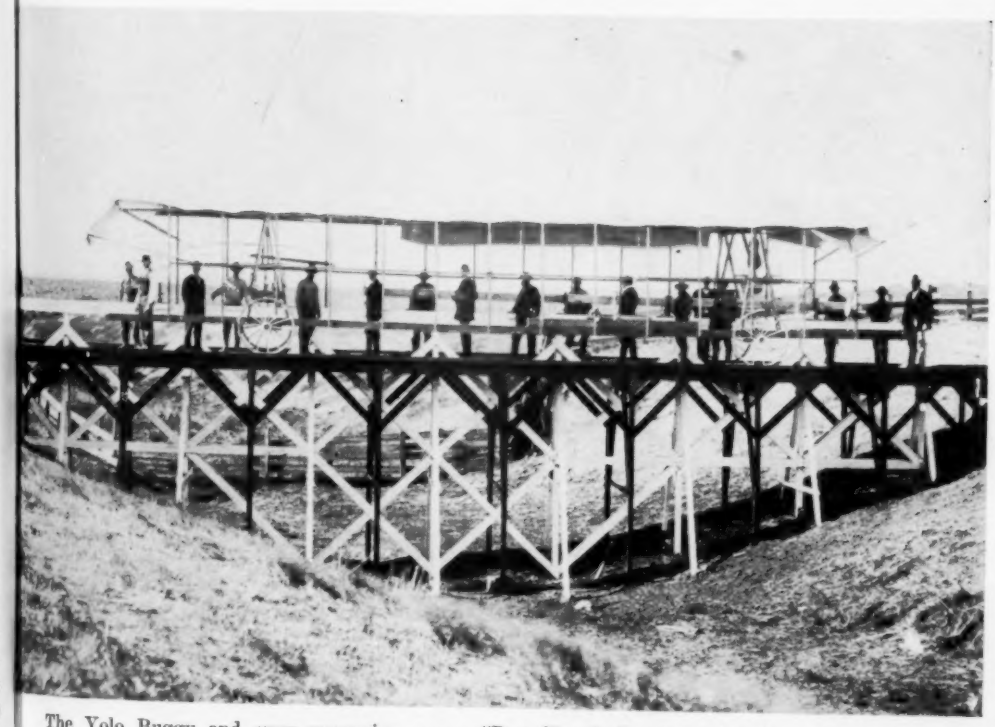
## WORK OF GEORGE DAVIDSON

When we look at the record in southern California, we see progress of control surveys painfully slow for a number of years. Parties were sent into the area for a few months and then ordered back to San Francisco or to the Northwest. Up to 1850 there were only eighteen fairly well determined geographic positions in southern California—all of them around San Diego Bay. In 1852–53, George Davidson measured a secondary base at San Pedro, about $6\frac{3}{4}$ miles long, and established the following stations: San Pedro Hill, West Beach, Buena Vista, Dominguez Hill, Los Cerritos, and Los Bolsas. During the years 1854 and 1888, schemes of subordinate triangulation were effected along the coast from the Mexican border northward to San Francisco. In 1881, almost 30 years after his first base measurements at San Pedro, Davidson returned to make the reconnaissance for the Los Angeles Base in the vicinity of Anaheim.

George Davidson, astronomer, engineer, geographer, historian, and author, will always stand in the forefront in any record of surveying and mapping on the Pacific Coast. He served actively for 50 years (from 1845 to 1895) in the Coast and Geodetic Survey. An account of the work of this remarkable man tells quite completely the story of geodetic control along the entire Pacific Coast, as he was actively engaged in nearly all of it. The Davidson quadrilaterals, the Pacific Coast Pilot, his early explorations in Alaska, his survey for a canal across the Isthmus of Darien, his many books on astronomical and historical fields—all give testimony to his genius and great energy. Davidson laid the groundwork for our geodetic control in southern California.

In 1888, under Davidson's direction, the Los Angeles Base, 17,494.2387 meters in length, was measured. The procedures used in the measurement of this base deserve some discussion. It was measured with 5-meter bars composed of two metals, steel and zinc, rigidly joined and cut to lengths, so as to compensate nearly for changes in temperature. It required 17 men to conduct the measurements. The bars were supported on heavy portable tripods and the party was covered with a movable tent 50 feet long, which could be moved along on wheels as the measurement progressed. Three measurements were made, taking 22 days

George Davidson and the "Yolo Buggy"—1881.



The Yolo Buggy and crew measuring across "Dry Slough Trestle," Yolo base line measurement—1881.

for the first, 15 days for the second, and 13 days for the third. An exhaustive program of daily comparisons with a field standard bar was followed. Temperatures were observed at each placing of the bar. The results speak for themselves—the probable error of the length was 18.2 mm., which was about 1/960,000 part of the length. The Yolo Base in northern California, previously measured with the same apparatus, had a probable error from all sources of about 1/1,000,000.

With the completion of these bases and their connection by triangulation, and with the extension of triangulaton to the Mexican border, it can well be said that first-order control had come to southern California. The main observations of angles on the primary or first-order net from Yolo Base to Los Angeles Base, and the extension to the Mexican border, were made during the years 1873 to 1899. The names of George Davidson, A. F. Rogers, O. H. Tittmann, D. B. Wainwright, E. F. Dickins, Ferdinand Westdahl, and A. T. Mossman stand out as the principal observers. That the work was well done is attested by the closures. The average closure of all triangles from Yolo Base in northern California to the Mexican border was 1.25″. The mean error of an angle was 0.93″. The length of the Los Angeles Base, as measured and as computed through the triangulation from the Yolo Base, differed by 41 expressed in terms of the seventh decimal place of logarithms, or expressed as a ratio, 1 : 110,000.

### DATUM ADJUSTMENTS FOR CALIFORNIA CONTROL

The several procedures which remained to tie this California control to that of the country as a whole, and to correct and adjust it to a proper geodetic datum were, briefly:

1. The adoption of the Clarke Spheroid of 1866 by the United States in 1880 necessitated recomputation of the California triangulation. The original work was computed on the Bessel Spheroid, based on European ares, but the long ares in the United States disclosed the need for a spheroid which more accurately fitted the true surface of the earth, the geoid. The Clarke Spheroid of 1866 is still used as the reference figure for all geodetic computations in the United States.

2. The connection and adjustment of the California ares to the rest of the United States control followed the completion of the transcontinental arc along the 39th parallel in 1900.

3. The correction and adjustment of azimuth by use of Laplace azimuths started in 1908. In spite of the accuracy with which horizontal-angle measurements are made, there is always present a tendency for an arc of triangulation to swerve to the right or to the left of the direction of progress, probably due to meteorological factors. Corrections by checking with astronomical azimuths are complicated by the deflection of the vertical due to nearby mountain masses or valleys. A Laplace azimuth requires that azimuth observations on Polaris be made at a station whose astronomic and geodetic longitude have both been determined. The difference of the two longitudes provides the data for correcting the observed astronomic azimuth for the tilting of the perpendicular.

4. Later the adoption of a suitable standard geodetic datum was undertaken. The final computation of extensive triangulation surveys requires two things: first, the exact shape of the mathematical figure which is a close approximation to the sea-level surface of the earth; and second, a point of origin, this being the latitude and longitude of some one station of the net. The first of these prerequisites was supplied by the Clarke Spheroid, previously mentioned. The station Meades Ranch in Kansas was chosen as the basic point of origin. The selection of this station was made after thorough investigation of the differences between astronomic and geodetic positions at a great number of stations throughout

the United States, in order to seek a point that would make the average algebraic difference between the resulting geodetic and astronomic positions approximately zero. The first horizontal datum was called United States Standard Datum. After its adoption by Canada and Mexico in 1913, it became the North American Datum. When a new adjustment of the triangulation became necessary because of the many new ares which had been added, the new designation "North American Datum of 1927" was given. This is the datum on which all of our geodetic control is now based.

We have reached one objective—a net of well-monumented stations, adequately described, and acceptably computed on a suitable standard datum. That the control has been used to good advantage is attested by the supplementary work done by many of you men here tonight, and by the organizations with which you are associated. Supplementary triangulation schemes, second to none in accuracy, have been carried out by the State of California, by Los Angeles County and City, by the Metropolitan Water District, by the United States Engineers, and others, to give us a respectable triangulation coverage.

There remained one final step to make all these data useful to surveyors and engineers, on both large and small projects. The adoption in 1933 of systems of State Plane Coordinates made it possible for practically every survey to be tied to geodetic control by ordinary plane surveying methods. However, another paper will be required to tell that story.

❦ ❦ ❦

## New Map of Northwestern U.S.

A NEW MAP of the *Northwestern United States and Neighboring Canadian Provinces*, issued in June 1950, completes the National Geographic Society's detailed 10-color postwar series of the United States. This series includes six maps covering, in addition to the Northwest, the Northeastern, Southeastern, South Central, North Central, and Southwestern United States. Except for the densely populated Northeastern section where the map scale is 1 : 1,750,000, or 27.6 miles to the inch, this series is on a uniform scale of 1 : 2,500,000, or 39.5 miles to the inch. The new map covers all five of the Northwestern states—Washington, Oregon, Idaho, Montana, and Wyoming, as well as the southern portions of the Canadian Provinces of British Columbia, Alberta, Saskatchewan, and a small portion of Manitoba. The map contains one inset covering the Puget Sound region from Olympia, Washington, to Vancouver, British Columbia, on a scale of 1 : 1,000,000. It follows the same general cartographic style as the rest of the series. Important automobile roads are shown in red; railroads in black; and topography is suggested by shaded hachures. National parks, monuments, and other features of scenic, historic, or natural history interest are emphasized; also such man-made changes as new dams and resulting lakes. It contains 7,317 place names. Physically the map is $36\frac{1}{2} \times 25\frac{1}{2}$ inches in size.

# Simple Uses of Photogrammetry by Surveyors

*By* EARL CHURCH

PROFESSOR AND HEAD, DEPARTMENT OF PHOTOGRAMMETRY, SYRACUSE UNIVERSITY

CONSIDERABLE EFFORT has been expended in studying the application of space geometry to aerial photographs. The effort has resulted in the publication from time to time of numerous papers presenting solutions of specific problems of photogrammetry, particularly some of the more basic problems of surveying and mapping. There is just enough difficulty about these problems and their analytical solutions to discourage most engineers and photogrammetrists from trying to use any mathematical analysis in photogrammetric work.

In fact, early European research in photogrammetry invariably led to the virtual abandonment of all efforts to use mathematical analysis in photogrammetry. As a result, the major research effort of two decades preceding the last war was expended on the perfection of precise optical instruments primarily designed to overcome the difficulties mentioned above. Several such instruments are at present receiving wide approval.

However, the enormous cost of such plotting instruments has prevented and will continue to prevent individual surveyors or small engineering organizations from making any wide use of photogrammetry. Recent research in theoretical photogrammetry, on the other hand, seems to indicate that the original methods of attack of the basic analytical problems were far from being the most advantageous. In fact, virtually all of the publications dealing with theoretical photogrammetry have started in such a manner as to necessitate leading the readers through a maze of somewhat useless complications and difficulties. A new system now proposed for attacking the theory of photogrammetry, had it been applied at the outset, might have forestalled vast expenditures of time, money, and effort in the development of complex and expensive photogrammetric equipment, and might have resulted long before this time in far wider applications of photogrammetry to the science of surveying and mapping.

A complete discusson of this topic is, of course, absolutely impossible in a brief paper of this nature. A fairly complete discussion of this new theory of photogrammetry, prepared by the writer of this article, is now in process of publication by Syracuse University. This book,[1] which will be available in a few months, may eventually prove to be of considerable interest to photogrammetrists, engineers, surveyors, and all users and manufacturers of photogrammetric equipment.

## BASIC PROBLEM

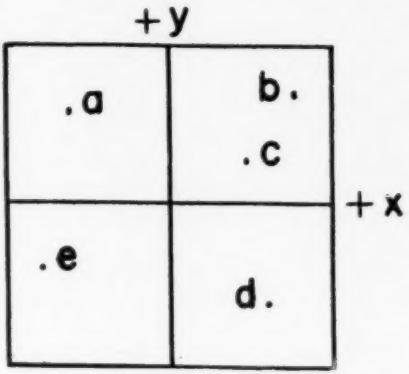
At the moment, and by way of illustration only, it is proposed to show here a solution of a very specific basic problem in photogrammetry. It is presented without proof, although the mathematical principles involved are very elementary and easily understandable, and merely illustrates how any engineer or surveyor might make very profitable use of photogrammetry. It must be regarded by the reader as a discussion of but a single problem.

Reprinted through the courtesy of the Ohio State University *Engineering Experiment Station News*, February 1949.

[1] CHURCH, EARL: Photogrammetry (Bulletin No. 19), *Syracuse University*, 1949.

Let us suppose that a surveyor has obtained a positive print on pigmented film base of an aerial photograph of terrain where he is interested in carrying on certain kinds of surveying. Let us say that he knows the exact altitude above sea level of the exposure station from which this photograph was taken, and the exact value of the focal length of the lens of the aerial camera. Let us suppose, also, that he knows the exact value of the tilt of this particular photograph, or the departure of the camera axis from a truly vertical line at the instant of exposure, this angle being designated here by the symbol $t$. In addition, he knows the exact direction of this tilt with reference to the geometric axes of the photograph, i.e., the exact value of the angle which the line from the geometric center or principal point of the photograph in the direction of the tilt makes with the positive direction of one of the photograph axes chosen as the y-axis. This angle is technically known as the swing and designated here by the symbol $s$.[2]

Let us suppose the engineer goes onto the ground and determines the elevations of several points, such as $A$, $B$, $C$, $D$, and $E$,[3] by running levels from some reliable bench mark or, much more easily and quickly, by using modern precise aneroid altimeters.




Aerial photograph (positive print). Known data: altitude = $Z_L$, focal length = $f$, tilt = $t$, swing = $s$.

## OBJECTIVE

Let us suppose the surveyor's objective is to obtain correct relative rectangular coordinates of this group of points. From these points he intends eventually to (1) make an accurate map of the points, (2) obtain the correct horizontal lengths of lines joining certain pairs of these ground points, or (3) determine the correct horizontal area of the land tract of which these points constitute the vertices.

There, then, is his problem: obtain correct relative rectangular coordinates of these points, perhaps indeed of many more. These coordinates must be rigorously corrected for any differences of elevation between the various points, and rigorously corrected (no approximations permitted) for the tilt of the photograph.

This problem is very basic in photogrammetry. Many photogrammetrists can doubtless supply a correct solution. Various heretofore published discussions of this problem or similar prob-

[2] Some photogrammetrists who read this paper may object to this problem on the assumption that an ordinary surveyor, even though he might be able to obtain such a photograph very readily, would (1) never be in possession of these given data, and (2) be unable to obtain them without complex computations based upon geodetic control data obtainable only by means of expensive ground surveying. This assumption is not true, however, as the complete new theory will show. The above-listed given data may be computed by very simple operations based upon a minimum of control data obtained at extremely low cost. The methods, of course, cannot be shown here.

[3] Capital letters $A$, $B$, $C$, etc., designate ground points; lower-case letters, $a$, $b$, $c$, etc., designate the same points on a photograph.

lems, however, have in many cases involved such troublesome details as marking the nadir point, or marking the isocenter, or even marking the principal line. Nearly all of these previous discussions have introduced such terms as "the tilt axis," "topographic relief displacements of images," "tilt displacements of images," "the variable 'scale' of the photograph," or many other needless ideas with which the various authors have elected to complicate their solutions.

## NEW METHOD PROCEDURE

In contrast, the new method offers the following procedure:

(1) The surveyor measures on his photograph, with a microrule, say, the rectangular coordinates of the images $a$, $b$, $c$, $d$, $e$, etc., based simply upon the rectangular geometric axes of the photograph. These measurements are called

| Point | $x$ | $y$ |
|---|---|---|
| $a$ | $x_a$ | $y_a$ |
| $b$ | $x_b$ | $y_b$, etc. |

(2) He then tabulates these measurements in the following form:

| | $m$ | $n$ | $k$ |
|---|---|---|---|
| $a$ | $-x_a$ | $-y_a$ | $+f$ |
| $b$ | $-x_b$ | $-y_b$ | $+f$ etc. |

where $f$ is the known focal length of the camera lens. These numbers are henceforth designated by the symbols $m_a$, $n_a$, $k_a$, etc.

(3) He makes up a table of nine numbers for the photograph, by finding the numerical values of the following expressions involving the known tilt, $t$, and the known swing, $s$:

| | $m$ | $n$ | $k$ |
|---|---|---|---|
| $X$ | $-\cos s$ | $\sin s$ | $0$ |
| $Y$ | $-\sin s \cos t$ | $-\cos s \cos t$ | $-\sin t$ |
| $Z$ | $-\sin s \sin t$ | $-\cos s \sin t$ | $+\cos t$. |

This table is made out but once for the photograph. These nine numbers are henceforth designated by the symbols $m_X$, $m_Y$, $m_Z$, $n_X$, $n_Y$, $n_Z$, $k_X$, $k_Y$, $k_Z$.

(4) Then a table is prepared as follows:

$M$

$$\begin{array}{ll} A & m_a m_X + n_a n_X + k_a k_X \\ B & m_b m_X + n_b n_X + k_b k_X \end{array}$$

$N$

$$\begin{array}{ll} A & m_a m_Y + n_a n_Y + k_a k_Y \\ B & m_b m_Y + n_b n_Y + k_b k_Y \end{array}$$

$K$

$$\begin{array}{ll} A & m_a m_Z + n_a n_Z + k_a k_Z \\ B & m_b m_Z + n_b n_Z + k_b k_Z, \text{ etc.} \end{array}$$

These numerical values are designated by the symbols $M_A$, $N_A$, $K_A$, *etc.*

(5) Finally, *correct relative rectangular coordinates* for the ground points are given by the simple relations:

$$\begin{aligned} X_A &= -(M_A/K_A)(Z_L - Z_A) \\ X_B &= -(M_B/K_B)(Z_L - Z_B) \\ Y_A &= -(N_A/K_A)(Z_L - Z_A) \\ Y_B &= -(N_B/K_B)(Z_L - Z_B), \text{ etc.,} \end{aligned}$$

where $Z_L$ is the known altitude of the exposure station of the photograph, and where $Z_A$, $Z_B$, etc., are the respective elevations of the ground points $A$, $B$, $C$, etc.

These relative rectangular coordinates for the various ground points are rigorously correct, regardless of how widely different the elevations of the ground points may be and regardless of the magnitude of the tilt of the photograph.

## CONCLUSION

The problems of the surveyor beyond this point, e.g., perhaps finding the correct horizontal lengths of lines joining pairs of ground points, or finding the correct horizontal area of the figure, or making a correct map of the points, become nothing more than ordinary plane surveying problems.

None of the usual complex matters regarding nadir points, isocenters, tilt

axes, image displacements, scale variations, etc., have either been used or even mentioned. Thus does the new treatment of the theory serve to simplify photogrammetric problems. Similarly, the new theory serves to resolve tilt analysis into a series of extremely simple operations, to reduce the amount of control data required, and to simplify the photogrammetric extension of control data, although, of course, these procedures are not shown here.

The simplicity of the operations enumerated, for a rigorous solution of a fairly difficult problem in photogrammetry, serves to show how useful photogrammetry can become for the average engineer or surveyor.



## New Three-Point Fix Method

THOSE WHO ATTENDED the Tenth Anniversary Meeting had the opportunity to look over a draft copy of the description of a new method for solving the problem of the three-point fix and to request mimeographed copies, which will shortly be issued as Publication No. 1 of the reestablished Maryland Bureau of Control Surveys and Maps. Fifty names and addresses were left, and 50 additional copies have been reserved for readers of SURVEYING AND MAPPING who may care to make similar request.

From the comments that have been received it appears that this method has some novel features. One is the tables of trigonometric functions which need be referred to only once; after setting down the cotangents of the observed angles, the tables may be discarded. Another is the providing of two checks which together insure absolute accuracy of the numerical work from start to finish. The determined position of the unknown point must agree exactly with the given data; else three simultaneous equations with two unknowns will not give identical answers.

This publication is not merely a list of directions which, if followed, will give a solution but is primarily a description of the logical development of the method, the many difficulties encountered, and the means taken to avoid the annoyances of numerical blunders which at one time constituted a very serious drawback. It is a method which can be reduced to routine with considerable saving of time as the operator becomes more familiar with the work. There will be added in the new edition several further improvements not in the draft copy and also a discussion of the extension of the method to four, five, and more fixed points.

It is felt that with simplified techniques the three-point fix can be effectively used for verifying traverses at points where established stations are visible, and, if confirmed by additional sights on other objects including Polaris if necessary, the usefulness of State Plane Coordinates may be greatly extended in many cases by the avoidance of long connecting traverses.

—CARROLL F. MERRIAM

(Copies of this publication may be obtained by writing to the Executive Secretary, ACSM, P.O. Box 470, Benjamin Franklin Station, Washington 4, D. C.—EDITOR)

# *Surveying and Mapping News*

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING.—EDITOR.

## CURRENT SURVEYING AND MAPPING LITERATURE

### MAGAZINE ARTICLES

THE WORLD OF RAND McNALLY. Harland Manchester, *Saturday Review of Literature*, January 21, 1950. (Gives an account of the history of Rand McNally and some of the problems encountered during its 86 years of map making.)

SHORAN FOR THE PHOTOGRAMMETRIST. Archer M. Wilson, *Photogrammetric Engineering*, March 1950. (Outlines photogrammetric mapping as envisioned at the Engineer Research and Development Laboratories.)

CIVIL ENGINEERING. Arthur Ridgway, *The Engineer's Bulletin*, March 1950. (A brief discussion of the various factors which make civil engineering one of the noblest of professions.)

NO ONE SOURCE FOR ACQUIRING MAPS. Edward B. Espenshade, Jr., *Library Journal*, March 15, 1950. (Discusses the special problems librarians have in the acquisition of maps.)

A GLOBE-MAP ACTIVITIES PROGRAM. Joseph E. Williams, *The Journal of Geography*, April 1950. (Various types of projections for world maps are considered for presenting to the student a realistic concept of the earth.)

CONTRIBUTIONS TO GEOGRAPHICAL KNOWLEDGE OF CANADA SINCE 1945. Andrew H. Clark, *The Geographical Review*, April 1950. (A review of recent geographical publications concerning Canada classified by regional and systematic studies.)

THE GULF STREAM. Henry Stommel, *The Scientific Monthly*, April 1950. (A brief history of the ideas concerning the cause of the Gulf Stream, contributed from Woods Hole Oceanographic Institution.)

DANISH PEARY LAND EXPEDITION, 1948–49. P. C. Winther and other members of the expedition, *Arctic*, April 1950. (Preliminary report of the 1949 wintering party in Peary Land, the northernmost country of the world.)

THE RADIAL LINE ASSUMPTION. E. H. Thompson, *Empire Survey Review*, April 1950. (The author discusses his reasons for believing that many English writers on this subject have deduced an incorrect formula for the magnitude of the error and have drawn wrong conclusions from the formula.)

THE USE OF AIR PHOTOGRAPHS BY THE ORDNANCE SURVEY. R. A. Gardiner, *Empire Survey Review*, April 1950. (Describes the Ordnance Survey's reasons for using air photographs and discusses their limitations.)

A NEW DETERMINATION OF THE VELOCITY OF RADIO WAVES. Carl I. Aslakson, *The Journal, Coast and Geodetic Survey*, April 1950. (Gives the results of a reinvestigation of Shoran data obtained on an Army Air Forces project in 1947 and arrives at the conclusion that the velocity of radio waves, which travel with the speed of light, is 299,792.3 kilometers per second instead of 299,776, the value heretofore commonly accepted and designed into the Shoran equipment.)

USE OF OCCULTATIONS AND ECLIPSES FOR CONNECTING GEODETIC DATUMS. Walter D. Lambert, *The Journal, Coast and Geodetic Survey,* April 1950. (Describes a method of tying together widely separated geodetic datums and some of the problems involved.)

GEODETIC APPLICATION OF SHORAN. Donald A. Rice, *The Journal, Coast and Geodetic Survey,* April 1950. (Discusses operating technique, computation and adjustment, and accuracy of method.)

AIDS IN AERIAL PHOTOGRAPHIC NAVIGATION. Lorne G. Taylor, *The Journal, Coast and Geodetic Survey,* April 1950. (Describes how position determination, coverage, forward lap, and side lap are solved by the use of the Norden Bombsight and the Astrocompass.)

PRECISION LEVELING FOR PILE-LOADING TESTS. Howard S. Rappleye, *The Journal, Coast and Geodetic Survey,* April 1950. (Describes special leveling equipment and methods used for testing the settlement of piles under load and recovery. Tests were made at the site of the new General Accounting Office building in Washington, D. C., as loads were released.)

HOW ACCURATE IS FIRST-ORDER TRIANGULATION? Lansing G. Simmons, *The Journal, Coast and Geodetic Survey,* April 1950.

HANDLING OF GEOGRAPHIC NAMES ON NAUTICAL CHARTS AND DOCUMENTS. *International Hydrographic Review,* May 1950. (Contains recommendations for obtaining approximate uniformity in the geographic names appearing on nautical charts and documents.)

PRACTICING SURVEYING IN THE UNITED STATES. S. A. Bauer, *The Canadian Surveyor.* Special Edition. Proceedings of the Forty-Third Annual Meeting of the Canadian Institute of Surveying and Photogrammetry, February 1 and 2, 1950. (Describes the status of the practicing surveyor in the United States and the standards of procedure and training involved.)

THE NEW MAP GRID SYSTEMS. D. D. Dunlop, *Anti-Aircraft Journal,* May–June 1950. (Discusses the two map grid reference systems adopted by the Army, Navy, and Air Force in a simplification and unification move.)

ARMY MAP SERVICE—NEW FOUR-COLOR PRESS. *The Military Engineer,* May–June 1950. (Describes a new four-color offset printing press capable of making 60 to 80 thousand impressions a day, which has recently been acquired by the Army Map Service.)

THE EARTH'S MAGNETISM. A. E. Benfield, *Scientific American,* June 1950. (Describes two theories recently advanced to explain the origin of the earth's magnetism.)

NEW SEAMOUNT IN THE NORTH PACIFIC OCEAN. Haven Nichols, *The Geographical Review,* July 1950. (Discusses seamounts discovered by Coast and Geodetic Survey ships during voyages between U. S. ports and Alaskan waters.)

A PROPOSED LAW FOR THE REGISTRATION OF ENGINEERS AND LAND SURVEYORS IN THE STATE OF COLORADO. Alfred J. Ryan, *The Engineers Bulletin,* July 1950.

SHORE-SHIP TRIANGULATION. William C. Hall, *The Military Engineer,* July–August 1950. (Describes a method of triangulation used in the Southwest Pacific by the 30th Engineer Topographic Battalion. Also contains a short discussion by C. A. Whitten on the Coast and Geodetic Survey's shore-ship triangulation in the Aleutians.)

SHORAN—ELECTRONIC TOOL FOR CONTROL SURVEYS AND MAPPING. J. L. Rannie, *Civil Engineering,* August 1950. (Describes how Shoran is used in Canada for control surveys and mapping.)

## BOOKS AND PAMPHLETS

STAGES AND DISCHARGES MISSISSIPPI RIVER AND ITS OUTLETS AND TRIBUTARIES, 1947. *Mississippi River Commission*, Vicksburg, Miss. 1949. 322 pages. $1.00. (Presents the results of stage and flow measurements made on the Mississippi River and its outlets and tributaries during 1947.)

MAPS. T. W. Birch. *Oxford University Press*, New York. 1949. 238 pages. $4.00. (Gives an account of topographical and statistical mapping, describes the instruments used in making modern maps, and deals with map reading and the preparation of graphs, diagrams, and diagrammatic maps.)

SUBMARINE GEOLOGY. Francis P. Shepard. *Harper & Bros.*, New York. 1949. $6.00. (The results of research in the field of oceanography are presented.)

ELEMENTS OF GEOGRAPHY. Vernor C. Finch and Glenn T. Trewartha. *McGraw-Hill Book Company, Inc.*, New York. 1949. 711 pages, 460 maps and plates. $6.00. (Deals with the physical and cultural elements of geography.)

HIGHWAY ENGINEERING, A CHALLENGE AND AN OPPORTUNITY. *The Advancement of Highway Engineering Committee, American Road Builders' Association*, Washington, D. C. 1949. 50 cents. 44 pages. (Designed to acquaint college students and others with the scope and possibilities of highway engineering.)

TECHNICAL LETTERING PRACTICE. Henry Spencer and Hiram M. Grant. *Macmillan Co.*, New York. 1949. $1.35. (A short, comprehensive course in technical lettering.)

SERVICE BOOKLETS "A" AND "B". *W. & L. E. Gurley*, Troy, N. Y. 1949. (Two pocket-sized booklets designed to aid field engineers in adjusting surveying transits and wye, dumpy, and precision-tilting levels. Free copies are obtainable from the publisher.)

GEOLOGY AND MINERAL DEPOSITS OF AN AREA NORTH OF SAN FRANCISCO BAY, CALIFORNIA (Bulletin 149). Charles E. Weaver. *Division of Mines*, San Francisco, Calif. September 1949. (This publication is comprised of descriptive material on geology and mineral deposits; a series of colored geologic maps printed on standard topographic quadrangles accompanies the text.)

STUDIES IN PHOTOGEOLOGY. Robert Helbling. *Art. Institut Orell Fussli A.-G.*, Zurich. 1949. 137 pages, diagrams, and illustrations. Maps in pocket. (Deals with the application of photogrammetry to geological mapping.)

TACHEOMETRIC TABLES. F. A. Redmond. *University of Hong Kong*, Hong Kong. 1950. 276 pages. 12s. net. (Consists of an introduction and four tables useful to the surveyor who uses tacheometrical methods.)

THE SEA AND ITS MYSTERIES: AN INTRODUCTION TO THE SCIENCE OF THE SEA. John S. Colman. *British Book Center, G. Bell and Sons*, New York. 1950. 285 pages. 12s. 6d.

RAPID TRAVERSE TABLES. Leo Jean Goldsmith. *Wm. C. Brown Company*, Dubuque, Iowa. 1950. 540 pages. $5.00. (This book was designed for solving problems in trigonometry, applied mechanics, surveying, and mapping. A pocket in the back contains a device known as the "Rapid Calculator" to be used in solving these problems.)

WEBSTER'S GEOGRAPHICAL DICTIONARY. *G. and C. Merriam*, Springfield, Mass. 1950. xxxi and 1293 pages and 177 maps. (A dictionary of places with geographical and historical information and pronunciation.)

—A. A. STANLEY

# Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the CONGRESS. It is the purpose of this Department to encourage comments on published material or the presentation of new ideas in an informal way. —EDITOR

## "KEUFFEL & ESSER 1950 SOLAR EPHEMERIS"

EDWARD G. WEST.*—I wish to make reference to the item on page 60 of the January–March 1950 issue of SURVEYING AND MAPPING, regarding the "Keuffel & Esser Solar Ephemeris."

For many years, in making surveys for the New York State Conservation Department, we have used the American Ephemeris and Nautical Almanac and computed the azimuth of Polaris through the sidereal time phase. To the neophyte, or to one without knowledge of astronomy, the various times such as standard, local, Greenwich, civil, and sidereal are somewhat confusing. Apparent right ascension is not always as apparent as its name implies.

Prof. Philip Kissam, of Princeton University, who wrote the chapter on celestial observations for the K. & E. ephemeris is to be commended on his method, which omits sidereal time and right ascension, and K. & E. should be congratulated on their use of it. This method should encourage a more extensive application of astronomical bearings, as no special astronomical knowledge is necessary.

Early this year we developed a computation form for use with the K. & E. ephemeris which not only serves as a guide to the steps of the computation but is convenient for filing with the other survey records. On this form, under correction for time zone, we have inserted the value of 5 hours as our work is all within the Eastern time zone. For other zones the applicable value is to be used. The form itself seems to be self-explanatory with one exception: There has been inadvertently omitted information to the effect that if the local hour angle is less than 180° the star is west of north.

It will be noted that we prefer the logarithmic computation for "Z" as described by Professor Kissam under procedure "B" in the ephemeris rather than the two-way interpolation under procedure "A." However, if a log book is not at hand procedure "A" may be followed.

Professor Kissam has seen the form and states that he thinks well of it. On his suggestion I am forwarding it in the hope that it will be of value to others.

It is my feeling that more stress should be put on the value of astronomic bearings for land surveys and that surveyors should be encouraged to make use of them. The time involved requires only a few minutes at dusk for field work and a few minutes for the office work. The confusion of changes in magnetic declination, local attraction, and disturbances is eliminated, and lines for all times can be easily and accurately reestablished.

Observations on the ends of unclosed transit traverses serve as a means to determine error in the angular closure. In the same way, some observations

* Forest Surveyor, New York State Conservation Department.

along the boundary of large tracts will help to control the angular measurements and often save hours checking in the office and in the field.

OBSERVATION FOR AZIMUTH

| | | | |
|---|---|---|---|
| POSITION<br>Lat. _____ Long. _____ | | DATE | Observation By _____<br>Computation By _____ |
| TIME | hrs. min. sec. | HOUR ANGLE | deg. min. |
| Watch Time | | Greenwich Hour Angle $0^h$ (Table 1) _____ (date) | _____ |
| Correction (Slow is +) | _____ | Correction for Greenwich Civil Time + (Table 5) | _____ |
| Standard Time 75 Meridian | _____ | Greenwich Hour Angle | _____ |
| Correction to 24 hour basis | 12 00 00 | Less West Longitude | _____ |
| Correction for Time Zone | 5 00 00 | | |
| GREENWICH CIVIL TIME (if over 24, subtract 24 hours and advance date 1 day) | _____ | LOCAL HOUR ANGLE | _____ |

| | | | |
|---|---|---|---|
| FORMULA FOR Z | $Z = \frac{\sin t}{\cos h} p$ | LOGARITHMIC COMPUTATION FOR Z | |
| t = Local Hour Angle above or 360° – L.H.A. (use smaller) | _____ | log sin t | _____ |
| | _____ | log cos h | _____ |
| h = true altitude (Latitude and Table 6 correction) | _____ | log p | _____ |
| | _____ | log Z | |
| p = polar distance (90° – declination) (expressed in minutes) (Table 3) | _____ | BEARING OF LINE | |
| | _____ | Z | _____ |
| | | Hor. Angle | _____ |
| | | Bearing | |

## Cornell Establishes Aerial Photography Center

CORNELL UNIVERSITY has established a center for integrated aerial photography to train scientists to use this technique for surveys in various fields and, through research, to extend its use to new areas. Donald J. Belcher is director of the center. The program includes technical work in the College of Engineering, in the fields of optics, geodesy, cartography, photogrammetry, instrumentation, and aeronautics. The Departments of Agronomy and Conservation and Soils in the College of Agriculture and the Department of Geology assist in air photo interpretation problems. The Department of Land Economics and the College of Architecture participate in land planning.—*Science*, July 14, 1950.

# CONGRESS NEWS

## Congress Elects New Officers

At the Tenth Anniversary Meeting the following officers and directors were elected for the ensuing year:

*Officers*

Gerald FitzGerald, *President*
Warren C. Crump, *Vice President*

*Directors*

(Two-Year Term)

William C. Wattles, *Property Surveys*
Arthur W. Kendall, *Topographic Surveys and Mapping*
Lansing G. Simmons, *Control Surveys*
Louis H. Berger, *Surveying Instruments*
William T. Pryor, *Construction Surveys*

In accordance with the amendment to the constitution, adopted at the Ninth Annual Meeting, terms of office for officers and directors will begin January 1, 1951.

## Reports of Technical Divisions and Committees

(As Presented at Tenth Anniversary Meeting, June 23, 1950)

### PROPERTY SURVEYS DIVISION

We do not have any formal report for the Property Surveys Division. I have before me the report of the secretary-treasurer, which was rendered to the chairman of the Division. Perhaps it would be appropriate to read it at this time.

The Division's activities for the past 6 months have been devoted to consolidation and development. By-laws have been drawn and approved by the executive board of the Division and by the Board of Direction of the Congress.

Membership lists for the Division have been prepared by the secretary. Director Teas, chairman of the Membership Committee, has been actively cooperating with Chairman Borden of the Congress Membership Committee, contacting and signing up new members and sending over 100 of President Bauer's invitation letters to licensed land surveyors in his vicinity.

Director Lundgren has been active in organization efforts in Illinois and has attained some success in gaining recognition and support for the Technical Standards and Fee Schedules.

Chairman Wattles was appointed temporary chairman by the Congress for the organization of a local section of the Congress in Los Angeles. This section was activated in January 1950, with about 100 members. The section has been holding public meetings and sponsoring programs of interest to the profession.

Other members of the Division across the country have been active in organization work and in spreading the benefits of Congress membership. President Bauer, also a director in the Division, has conducted a large amount of correspondence on behalf of the Division.

Mr. Gordon Ainsworth has been appointed as Division advisor to the Forest Survey Committee of the New England Section of the Society of American Foresters and reports progress in a legislative program for the benefit of forestry surveyors, which conforms with standards recommended by the Division.

Vice Chairman Berry, committee chairman of the Surveyor Training Program, has formulated some ideas on that subject that he wishes to present to the Division.

The carry-over Committee on the Handbook (John Goggin, chairman) has made a recommendatory report which is very complete and impelling. It will be submitted to the executive board for study and later presented to the Congress.

The secretary reports a balance of $46.45 in the treasury.

The Division had a meeting this morning. We have discussed the subject of the training of surveyors and what particular means would be best suited for seeing to it that the surveyor of the future is a better trained individual than the surveyor of today. We have a committee appointed to go into that subject at length. We are also pushing the production of a Handbook for Property Surveyors, which we hope will cover a great deal of the material which at present is unavailable in any organized form.

An election of officers was held for the first time under the new constitution. The results are as follows:

*Officers*

William C. Wattles, of California, *Chairman*
Ralph M. Berry, Washington, D. C., *Vice Chairman*
Robert L. McCammon, of Vermont, *Secretary-Treasurer*

*Directors*

Howard Teas, of New York
Arnold Lundgren, of Illinois
Prof. Frank Mirgain, of New York
John Goggin, of Michigan

RALPH M. BERRY,
*Vice Chairman*

## CARTOGRAPHY DIVISION

This report will be a summary only of the activities of the Division for the past year. Most of the items mentioned here were covered in considerable detail at the Cartography Division's business meeting earlier this morning.

Although the resignation of one director and several committeemen set us back slightly during the year, the Executive Committee and Sub-Committees were completely reorganized and are now giving a new impetus to the affairs of the Division.

The by-laws under which the Division had been temporarily working were formally approved by the Board of Direction of the Congress on December 12, 1949, and the following incumbent officers are the first to be selected under them:

*Officers*

Warren C. Crump, *Chairman*
Robert J. Voskuil, *Vice Chairman*
M. S. A. Delaney, *Secretary-Treasurer*
Arthur F. Striker, *Associate Editor*

*Directors*

Gordon B. Littlepage
B. D. Price
Loren A. Bloom
Oscar H. Nelson
Robert J. Voskuil
Newman Bumstead

*Committee Chairmen*

Robert L. Moravetz, *Nominations*
William E. Davies, *Program*
Gordon B. Littlepage, *Membership*
Albert Materazzi, *Research and Development*
John R. Dickens, *Technical Standards*

This group and the committee members represent a broad variety of experience in industry, government, and education, and I desire to thank them again for their past support and cooperation.

Five Executive Committee meetings have been held since January 1, 1950, to prepare plans for this Anniversary Meeting and to take care of other affairs of the Division.

The Program Committee is making arrangements for two special meetings, to be sponsored by the Division, one to be held in October 1950, the other in February 1951. Their programs will include papers, perhaps combined with panel discussions, on some current interesting topic in the field of cartography. These meetings will be held in the evening, and it is expected that all members living in the Washington Metropolitan Area will be notified concerning them.

Our Research and Development Committee is actively collecting information and material of interest which will be disseminated to the members, either through the Journal or printed independently.

Our Membership Committee has worked very steadily with the Membership Committee of the Congress, and the results are most gratifying. The secretary's file shows an increase in addresses of nearly 70 percent over the previous year, and continuous efforts are being made to contact those potential sources of membership who have a special interest in this Division.

Numerous inquiries were received from state governments, universities, and other agencies, requesting information on standards, new developments, and the general affairs of the Division.

Several of the officers and committeemen have worked closely with organized groups in establishing military, aeronautical, and nautical map and chart standards for government use.

We were again pleased to have Vice Chairman Robert Voskuil represent the

Division at the Annual Meeting of the American Association of Geographers. Mr. Voskuil participated in a panel discussion on cartography and presented a paper on "Cartography in Government."

An increased number of general and technical articles in the field of cartography has appeared in recent editions of the Journal. The Division officers are of the opinion that there is much that can be written on this broad phase of mapping and wish to encourage your contributions to this program. Any desired editorial assistance will be furnished.

The remainder of the present year, as well as the coming year, should show a considerable increase in the activity of the Division.

WARREN C. CRUMP,
*Chairman*

## CONTROL SURVEYS DIVISION

Early in 1950, the board of directors (Floyd W. Hough, Army Map Service, chairman; R. M. Wilson, U. S. Geological Survey; and Carroll F. Merriam, Pennsylvania Water & Power Company) appointed the following officers and committee chairmen:

*Officers*

Prof. W. O. Byrd, Ohio State University, *Associate Editor*
C. A. Whitten, U. S. Coast and Geodetic Survey, *Secretary*

*Committee Chairmen*

J. C. Carpenter, Public Roads Administration, *Highway Surveys*
R. M. Wilson, U. S. Geological Survey, *Technical Standards*
William T. Pryor, Public Roads Administration, *Membership*
Comdr. C. N. Thomas, U. S. Coast and Geodetic Survey, *Public Education*
Homer C. Fuller, Army Map Service, *Research and Development*
Capt. C. L. Garner (Ret.), U. S. Coast and Geodetic Survey, *Nominations*

A business meeting of the Division was held on Friday morning, June 23, in conjunction with the Tenth Anniversary Meeting of the Congress. About 70 members and guests were present.

The Nominating Committee reported the selection of B. Everett Beavin, of J. E. Greiner Company, as the nominee for director for a 3-year term beginning January 1, 1951. There were no additional nominations. Mr. Beavin was elected by the membership of the Division.

The chairmen of the various standing committees gave reports in which the activities of the past few months and the plans for the future were included. A special feature included with the report of the committee on highway surveys was a special report by D. W. Loutzenheiser, Public Roads Administration, on the comments received from various state highway associations on the tentative standards which have been prepared for highway surveys.

Prof. Allyrio Hugueney de Mattos of the Geographic Institute of Brazil reviewed briefly the extension of control surveys in his country. Dr. Erwin Gigas, Director of Land Survey Office, Bamberg, Germany, made a few remarks concerning the status of survey work and the manufacture of surveying instruments in Western Germany.

In view of the limited time available for this meeting, it was not possible to permit discussion on the reports or talks. The meeting adjourned at 10:30 A. M.

FLOYD W. HOUGH,
*Chairman*

## TOPOGRAPHIC SURVEYING AND MAPPING DIVISION

As you probably know, the Topographic Surveying and Mapping Division has just been reactivated. Last year at President Wright's request, I organized a committee to do that job. We drew up a proposed constitution, which was approved by the Board of Directors. Under its provisions we selected a slate of officers, obtained their consent to run, and conducted an election.

That was reported a little over a month ago, so, because we are still a rather new division, we have no formal report to make.

The officers elected are as follows:

*Officers*

C. S. Maltby, U. S. Geological Survey, *Chairman*
Jasper E. King. U. S. Forest Service, *Vice Chairman*
Shirley Griffith, U. S. Coast and Geodetic Survey, *Secretary-Treasurer*
Jacob Skop, Army Map Service, *Associate Editor*

*Directors*

(To serve for 3 years)

Jasper King, U. S. Forest Service
T. W. Norcross, formerly, U. S. Department of Agriculture

(To serve for 2 years)

Robert Smith, Aero Service Corporation
J. S. McCall, Army Map Service

(To serve for 1 year)

Louis Woodward, Jack Ammann Company
Shirley Griffith, U. S. Coast and Geodetic Survey

*Committee Chairmen*

Roscoe J. French, U. S. Coast and Geodetic Survey, *Program*
Jasper E. King, U. S. Forest Service, *Technical Standards*
J. S. McCall, Army Map Service, *Research and Development*

We had a very interesting meeting this morning. Several practical ideas were presented. When the transcript is available I will be better able than now to report on what we plan to do.

I do have one other thing to mention. When we started out, Mr. Dix gave us the names of, I think it was, 57 members of the Congress who expressed topographic surveying and mapping as their first interest. Our recently compiled membership list carries 126 names, to which we added several this morning .

C. S. MALTBY,
*Chairman*

## SURVEYING INSTRUMENTS DIVISION

The Surveying Instruments Division held a meeting this morning out in the open, just outside the ballroom here, and attendance unfortunately was not too satisfactory. The officers who served last year were reelected for the coming year in order to give some continuity to the section. Preliminary plans for the program next year were drafted, which we hope will stimulate a little more interest.

LESTER E. DEMLER,
*Secretary*

## BUDGET AND FINANCE COMMITTEE

I did not expect to make any report on the budget, because, as a matter of fact, we have not had enough experience for the budget to warrant a report. This is the first year we have ever had a budget.

I am not going to bore you with a lot of figures, because you heard the reports of the secretary, the treasurer, and the Membership Committee, and you have most of the budget report already.

I do want to ask though, first: Why should we have a budget? We got along for 9 years without it. Why should we need one now?

In my opinion, any business is healthy only if it lives within its income. Our income is not within our control, but our expenditures certainly are.

I suppose that a good many of you have gotten yourselves into the same position which I did. When I was first elected as a director and sat in on the meetings in 1948, I was more and more disturbed at the financial situation of the Congress. No one else seemed to share my concern; it was merely pointed out that we had so many thousand dollars in the bank account, that last year at that time our finances were so-and-so, and this year they are so-and-so.

Well, we always seemed to have enough money. I complained at that attitude and also expressed my fears that we were spending more than we were taking in, until—you can guess the result—I was saddled with the job of budget and finance.

So I began going retroactively into the books and figures and found that my concern was well placed, because in the calendar year 1948 the Congress spent $489 more than it took in.

I was a little happier about 1949, because we spent eighteen hundred and some dollars less than we took in.

As I say, this is the first year we have had a budget. We are obligating the Congress to some additional things for which money has not heretofore been spent. I think we are justified, and so do the directors.

This is not my budget; it is your budget, and your directors are the ones who voted it. Admittedly, it is based on a higher rate of income than we had last year, and with all due respect to our secretary, I still think it is not unduly optimistic. We may find that it is a little bit out of line, but we have some leeway in here to take care of that, if necessary.

I will read the figures, though, of what I call the operating income, that is, income after all expenditures that were caused in obtaining that income had been deducted. In 1948, we had an operating income of $5,407. In 1949, we had an operating income of $7,862. In 1950, the budget is based on an operating income of $10,600.

The present budget, as it has been approved by the directors, estimates a surplus of $3,088 for the calendar year. Now, I said we had a cushion, and I think that is a pretty allowable cushion.

In my opinion, the Congress should never spend in any one year more than it takes in, and for its own health I would like to see it take in at least $1,000 more than it expends.

So as you see, we have a cushion here of $2,000, which I think will calm our secretary's fears.

K. T. ADAMS,
*Chairman*

## MAP SCALES COMMITTEE

The committee assigned to the task of making a report on the resolution passed at the 1949 Annual Meeting, calling for an investigation of the multiplicity of topographic map scales used by Federal map-making agencies, has not yet completed its studies.

The committee requested, and has now received, detailed statements from each topographic mapping agency, indicating the reasons for using their scales. The final statement was not received until just a few weeks ago.

Each of the committee members now has copies of all these statements and is studying and evaluating them. As soon as they have completed their analyses, they will submit individual reports which will be combined into a final summary and published in SURVEYING AND MAPPING.

I appreciate the excellent and wholehearted cooperation the committee has received from the mapping agencies and hope that our report will clarify the situation which inspired the resolution.

For those who may be interested, I wish to say that the other members of the committee are Dean F. M. Feiker, George Washington University; Prof. G. Brooks Earnest, Case Institute of Technology; Dr. Carl Mapes, Research Chief of Rand McNally & Company; and Robert L. Wing, Division of Water Resources of California.

HELMUTH BAY,
*Chairman*

## PUBLICATIONS COMMITTEE

I think that the past issues of SURVEYING AND MAPPING testify to the committee's activities. There is, and I suppose there will always be, a shortage of articles. So, I would like to urge every member of the Congress to take his pen in hand and help us out by writing some articles and sending them in. We will do the necessary polishing up that may be required. It is nice to see your name in print once in a while, and Mr. Shalowitz will see that it is spelled correctly.

Any story that you have is the story we are after, and I know that you all have lots of them.

I want to thank the members of the Committee for their cooperation and also Mr. Shalowitz, to whom the credit must be given for carrying the bulk of the load and bringing the Journal out on time.

HELMUTH BAY,
*Chairman*

# Urgent Legislation

AS REPORTED in the July–September 1950 issue of SURVEYING AND MAPPING, the Tenth Anniversay Meeting unanimously adopted a resolution endorsing and strongly urging the adoption of H.R. 6900, and its Senate counterpart S. 2989, entitled "A bill to provide an accelerated program for surveying and mapping of the United States, its Territories and possessions, and for other purposes," and to be known as the "National Surveying and Mapping Act of 1950." The bill has been favorably reported by the Committee on Public Lands and is now before the House of Representatives awaiting approval.

The pending bill is one that will benefit every member of our organization. It provides for basic control, which will be available to all branches of surveying, and for topographic, hydrographic, geologic, soil, and forest maps—all necessary to efficient and economical development of our resources.

The chief aim of the American Congress on Surveying and Mapping is to advance the science of surveying and mapping, in furtherance of the public welfare and in the interests of both those who use maps and surveys and those who make them. Here is an opportunity to put into practical effect this major objective. Every member is urged to support this bill; to actively disseminate information concerning it and its objectives; and, in case the bill is not passed by the 81st Congress, to continue with his support to insure that a similar bill is introduced and passed by the next Congress.

For the information of our membership, an abstract of the bill is presented herewith together with an explanation and an analysis of the bill as contained in the Report of the Committee on Public Lands of the House of Representatives.

SOL A. BAUER, *President*

## Abstract of H.R. 6900

Section 2 of the bill is a statement of policy, and recites that: "It is the purpose of this Act to establish accelerated programs of topographic, geologic, geodetic, soil, and hydrographic surveying and mapping of the United States, its Territories and possessions and offshore areas, and the cadastral surveying of the public domain and other Federal public lands in order that suitable surveys and maps will be available within the shortest period of time consistent with the orderly recruiting of personnel and the effective scheduling of such programs."

Section 3 provides for expansion and acceleration of topographic mapping of the United States in 20 years; expansion of geologic mapping to permit its completion in 30 years; accelerated topographic and geologic mapping programs in Alaska and in other territories and possessions; and geologic mapping of submarine areas offshore from the United States, its territories and possessions.

Section 4 provides for geodetic control in advance of the needs of the surveying and mapping programs, and for surveys and charts, with adequate submarine contours, of offshore areas for development of mineral and of aquatic and other marine resources.

Section 5 provides for development of a program to complete the soil mapping of the United States in 30 years, and to meet the needs for development of resources and settlement of Alaska and other territories and possessions.

Section 6 provides for adequate surveys and markers on the public domain within the United States with resurveys where necessary, establishment of markers and subdivisions to meet the needs in mineralized areas, to be completed in 10 years, and for the necessary accelerated program in Alaska and other territories and possessions.

The other sections of the bill set forth details concerning the carrying out of its provisions, submission of yearly reports of progress, and authorization for appropriation of the necessary funds.

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## Extracts From Report to Accompany H.R. 6900

The Committee on Public Lands held hearings on the bill and statements of approval were presented by the Coast and Geodetic Survey; the Bureau of the Budget; the United States Geological Survey; the Bureau of Plant Industry, Soils, and Agricultural Engineering; and the Bureau of Land Management. Following the hearings the Committee submitted a Report to the House of Representatives explaining and analyzing the bill. The following are extracts from the Report.

### EXPLANATION OF THE BILL

"A great portion of the development in this country has been due to the utilization of our natural resources; however, the very richness and abundance of these natural resources have often led to wasteful use of many resources until we are faced with scarcity where formerly there was abundance.

"Despite the fact that the United States is one of the most advanced nations of the world in respect to its position in science, engineering, transport, business, and industry, it has lagged far behind other forward-looking nations in completing topographic and geologic maps of its area. In fact, most of these other nations have long ago completed their entire series of detailed maps, and maintain adequate mapping forces to keep maps revised and up to date.

"The Federal Government owns in the continental United States 455,146,726 acres, which represents 23.89 percent of the land area in the continental United States. It owns more than 98 percent of the Territory of Alaska. In addition thereto, it has mineral reservations on other large acreages; it has forest and water power resources, and many other natural resources where the fee may not actually be owned by the Federal Government.

"Great construction programs, being more spectacular than a mapping or scientific program, have taken the greater portion of our appropriations, but in many instances such construction programs have had to proceed on the basis of inadequate knowledge of the resources with which we are working.

"The logical starting point for most Federal and non-Federal projects in a wide variety of natural resources are suitable maps. Yet these are often not available. Our mapping programs are generally proceeding so slowly that, at the current rate of progress, it will require from 40 to 100 years for their completion. There is universal recognition that nothing would contribute more to an effective and judicious development of our resources and the economical operation of our many activities than a complete set of maps showing the necessary surface and subsurface features. Such maps are necessary for the effective development of our mineral and water resources, the effective use of our soils, the location of highways, railways, dam sites, industrial plants, telephone and electric lines, radio transmission stations, airports, reclamation projects, drainage projects, and almost all activities dealing with the surface of the earth and the development of its resources. The effective use of the soil in the production of

farm crops, timber production, and other useful plant life can best be understood and carried out with suitable maps available.

"Military needs are no less important than peacetime economic needs. They are actually almost identical since military might depends upon strong economic and industrial institutions and activities, and these are everywhere dependent upon effective use of natural resources. The very existence of our country and its independent functioning may actually hinge on vital resources of which we may not now be aware but which may be brought to light by an accelerated mapping program. We have developed those resources that have been exposed by nature or that are just beneath the soil surface, but we know so little about our subsurface deposits and how the underground formations may be used in the conservation and more effective use of our water and mineral resources, that our potentials still are largely unknown and our development cannot be placed on a sound basis until more complete information is available. The completion of our mapping program in all its important aspects at the earliest practical date consistent with the efficient scheduling of these accelerated programs would seem to be the most fundamental and sound step for us to take.

"Based on these interpretations, an accelerated surveying and mapping program has been prepared for consideration of the Congress. Extensive study and conferences have produced a complete and fully coordinated program of surveying and mapping in all its essential forms that can provide an efficient, well-planned program of completing required surveys and maps of the entire country and give us the scientific foundation we now lack. The program also provides for an extension of the required surveys to the offshore areas as far as the edge of the Continental Shelf and beyond where necessary and the required surveys and maps in Alaska and other Territories and possessions in order that the same scientific foundation will be readily available for the development of the resources beyond the bounds of the continental United States. The total cost of these surveys and maps will probably not equal even 1 percent of the total value of the construction programs based on natural resources.

"This small relative cost will be saved many times in reduced costs of construction and will be of even greater value in insuring wise development of our resources. Such a program will make it possible to plan carefully and thus replace our present slow, uncoordinated surveying and mapping program with an accelerated, carefully planned and coordinated undertaking. It will provide the type of scientific foundation we are in great need of for the development of our resources and it will do much to insure the soundness of the many economic and security activities carried on not only by the Federal Government but by all the States and innumerable private industry activities.

"This bill is the result of a long study made by the Bureau of the Budget, Department of the Interior, Department of Commerce, and the Department of Agriculture, as well as the Public Lands Committee. It represents coordinated effort and has the approval of all the departments. . . ."

ANALYSIS OF THE BILL

". . . All of the various types of surveying and mapping programs provided for in the bill are already being carried on by various Federal agencies under programs long provided for by the Congress. The bill makes no fundamental change in the allocation of responsibility for these activities among the various Federal

agencies. The chief purpose of the bill is to provide an accelerated program of surveying and mapping to meet the needs of the country without altering the distribution of activities among the agencies now responsible for these programs.

"The need for acceleration arises from the slow rate at which these surveying and mapping programs are now being carried on and the rapidly growing needs of the country for surveys and maps to establish sound foundations for the current intensive development of our natural resources and for many other important purposes for which they are essential. Under prevailing schedules it will require from 40 to 100 years to complete these programs. The justification for the accelerated program comes primarily from the extensive needs for these surveys and maps for a multitude of current and continuous uses by the Federal Government, the State and local governments, and a wide variety of industries, corporations, and individuals.

"Under existing circumstances, many Government and private agencies find it necessary to improvise maps and surveys for their special needs, often at great cost and generally of limited usefulness to others. The ready availability of suitable surveys and maps would fill most of the needs of all agencies and would provide a sound foundation for many programs involving the use of the earth's surface and its many resources.

"The surveying and mapping of the country will eventually be completed, even under present programs. From a long-run point of view, the accelerated programs do not call for an increase in expenditures but rather for a concentration of effort and expenditures over the next 20 to 30 years and a reduction beyond that time. Experience, however, has demonstrated that the availability of the surveys and maps will reduce expenditures in so many other directions that the cost to the Federal Government, even in the shorter period, probably will be offset many times over by savings in other directions. . . ."

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## Depth Recorders Help Locate Oyster Beds

OYSTER BEDS can now be located through the use of depth-recording equipment, reports Dr. A. F. Chestnut of the Institute of Fisheries Research in Morehead City, N. C.

The portable instrument sends out sound waves that are echoed back through the water from the bottom and recorded. By checking the differences in the intensities of the recordings, the kind of bottom surface was determined.

When a hard bottom rising a few feet above the surrounding mud was located, there was the oyster bed. Dr. Chestnut states that it was possible to distinguish shell bottom from hard sand, although scattered oysters lying on hard sand bottom were not easily distinguishable. He reports his findings in the journal *Science* (June 16).—*Science News Letter*, July 1, 1950.

# NEW MEMBERS

## INDIVIDUAL MEMBERSHIPS

ABBOTT, CLINTON W. W., Civil Engineer, 4418 54th St., Sacramento, Calif.

AIKMAN, C. F., Surveyor, 204 Welch Blvd., Flint, Mich.

ALBEAR, JESUS F. de, Ing., Calle 25, No. 160, Vedado, Havana, Cuba.

ANDREWS, EDWARD G., Surveyor and Civil Engineer, P. O. Box 485, Wrens, Ga.

ARLOSKY, CHAS. F., 4922 So. Chesterfield Rd., Arlington, Va.

BENEDUM, WILLIAM G., Surveyor, Miner Rd., Gates Mills, Ohio

BROWN, WHITMELL C., Surveyor, 6 Aaron St., Martinsville, Va.

CALAHAN, PECOS H., Civil Engineer, Rm. 529, 1020 "N" St., Sacramento, Calif.

CALLAN, KYLE W., North Main St., Marion, Va.

CALVACHE D., ANTONIA, Director, Inst. Cartografico Nacional, Havana, Cuba

CANTRELL, TERENCE B., Surveyor, 15460 Stout Ave., Detroit, Mich.

CAREY, WALTER, Civil Engineer, 159 Manning Ave., River Edge, N. J.

COGGIN, HARRY L., SR., Walnut Hill S. West St., Falls Church, Va.

COLLIER, ROB M., U. S. Geological Survey, Box 133, Rolla, Mo.

COOK, NORMAN T., Civil Engineer, Socony-Vacuum Oil Co., Apartado 246, Caracas, Venezuela

CORLEY, SAM T., Surveyor, 325 Rockbridge Rd., Avondale Estates, Ga.

CRAWFORD, THOMAS W., Cadastral Engineer, 1245 N. 29th St., Billings, Mont.

DAVIES, CHAS. H., Photogrammetrist, 9613 Bristol Ave., Silver Spring, Md.

DICKENS, JOHN R., 4804 Alton Pl., N.W., Washington, D. C.

DICKSON, GEORGE M., Box 524, Hamilton, Mont.

DIGGORY, MARK L., Surveyor, 11 Beechwood Dr., Glen Head, N. Y.

DINGMAN, ROBERT O., Surveyor and Civil Engineer, 34 Maple St., Palmer, Mass.

DOBBIN, JOHN V., 1931 Calvert St., N.W., Washington, D. C.

DORNHOEFER, LOUIS, Surveyor, 10959 110th St., Ozone Park, N. Y.

DUDLEY, EDGAR E., 125 S. 68th St., Birmingham, Ala.

DUMAS, ARMAND, Surveyor and Forest Engineer, 805 Royal St., Box 90, Malartic, P. Q., Canada

EASTWOOD, HERBERT E., 5504 Charlcote Rd., Bethesda, Md.

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FOLMAR, JAMES M., Civil Engineer, Box 12, Montgomery, Ala.

FRENCH, ROSCOE J., 3921 Elbert Ave., Alexandria, Va.

GEORGE, FLOYD C., Surveyor, Gamle Gade #28, P. O. Box 571, Charlotte Amalie, St. Thomas, V. I.

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GUTHE, OTTO E., Dr., 3015 Albemarle St., N. W., Washington, D. C.

HAMMOND, LEIGHTON S., Surveyor, 11277 Richland Ave., Los Angeles, Calif.

HAND, SAMUEL P., Geodetic Engineer, 2316 N. Evergreen St., Arlington, Va.

HARRINGTON, EARL G., Bureau of Land Management, Washington, D. C.

HARVEY, ROBERT B., JR., 205 N. Valley Rd., Colonial Hts., Va.

HATHORN, STANLEY J., 906 Prince St., Apt. 405, Alexandria, Va.

HAUPT, RICHARD W., Ensign, 1736 30th St., S. E., Washington, D. C.

HAWKEN, C. C., Surveyor and Civil Engineer, Box 101, Winterville, Ga.

HUMPHREYS, WILFRED, Chief Land Surveyor, Can. Pac. Railroad, Winnipeg, Canada

KIRLYS, PRANAS, 7002 Lawnview Ave., Cleveland, Ohio

KNIGHT, CHARLES E., Surveyor and Engineer, 7385 Poe Ave., Detroit, Mich.

KOHUN, ALEX., 10413 Reno Ave., Cleveland, Ohio

KRAHMER, EDWARD A., 1109 N. Highland St., Arlington, Va.

KRAUS, VIRGIL K., 1616 14th St., Sacramento, Calif.

KUZMICKI, FELIX D., Surveyor and Civil Engineer, Southeastern Eng. Service, Monroeville, Ala.

LAMPP, EDWARD R., Surveyor and Engineer, 210 Todd Bldg., Ocala, Fla.

LAW, ROGER D., Surveyor, 8 Princess St., Bellmore, N. Y.

LINDSAY, ROBERT J., C. E. and Quebec Land Surveyor, Room 808, Tramways Bldg., Montreal, P. Q., Canada

LODGE, FRIEND H., Civil Engineer, Planning and Zoning Commission, 201 Fiscal Ct. Bldg., Louisville, Ky.

LOEFFLER, M. M. J., Surveyor and Civil Engineer, 13674 Thornton St., Detroit, Mich.

LYONS, WILLIAM A., Engineer, 1001 20th St., Newport News, Va.

MANGAN, GRACE A., (MRS.) 2730 10th St., N. E., Washington, D. C.

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MARGOLIN, JOSEF, 31 Lilienblum St., Tel Aviv, Israel

McCARTHY, E. R., Comdr., U. S. Coast and Geodetic Survey, Washington, D. C.

MITCHELL, MARGARET H., (MRS.) 6841 N. Washington Blvd., Falls Church, Va.

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NEARY, FLOYD B., 1109 N. Highland St., Arlington, Va.

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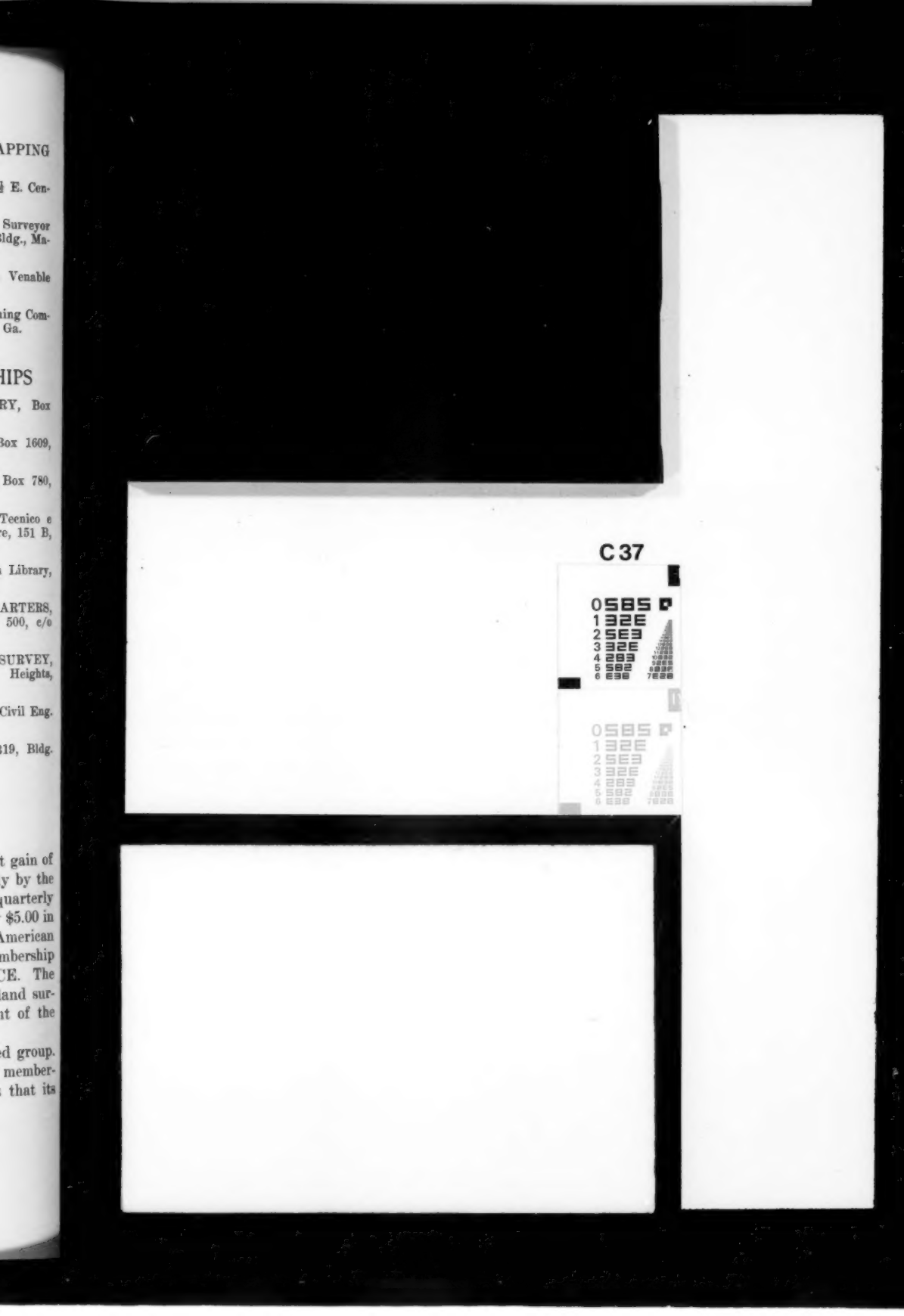
## An Important Forward Step

THE AMERICAN CONGRESS ON SURVEYING AND MAPPING will enjoy a net gain of approximately 50 new members as a result of action taken recently by the Nassau-Suffolk Civil Engineers, Inc., of Long Island, N. Y. At its quarterly meeting on October 18, 1950, it was voted to increase the annual dues by $5.00 in order to provide its members with dual status in both the NSCE and the American Congress. This welcome news is contained in a recent letter to our membership chairman, Capt. Frank S. Borden, from Mr. Howard J. Teas of the NSCE. The members of the association are all licensed professional engineers or land surveyors engaged in practice in Nassau and Suffolk Counties. President of the group is Alden W. Young.

This is the first instance of such action being taken by an organized group. The American Congress on Surveying and Mapping welcomes into its membership the members of Nassau-Suffolk Civil Engineers, Inc., and hopes that its action will inspire other such associations to consider similar action.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